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GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: 3/2/79 OH

Project Title: Demonstration: Filtration of Waste Stabilization Pond Effluents (Green C ...)

Project No: E-26-641 [Continuation of A-1923 which began 11/17/76]

Project Director: Dr. T. F. Craft

Sponsor: Coastal Plains Regional Commission; Charleston, SC 29401

Agreement Period: From 1/1/79 Until 11/17/79

Type Agreement: Grant No. 10740003

Amount:	CPRC	GIT	TOTAL
	$122,098.58 [A-1923]	$7,736 [E-862-001]	$129,834.58
	8,117.42 [E-26-641]	514 [E-26-321]	8,631.42
	$130,216.00	$8,250	$138,466.00

Reports Required: Semi-Annual Reports; Annual Reports

Sponsor Contact Person (s):

Technical Matters

McIver Watson, Program Officer

Contractual Matters (thru OCA)

James W. Butler, Executive Director

Coastal Plains Regional Commission
215 East Bay Street
Charleston, S. C. 29401

803/724-4250

Defense Priority Rating: n/a

Assigned to: Nuclear Engineering (School/Laboratory)

COPIES TO:

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- Division Chief (EES)
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- Project Code (GTRI)
- Other _____

CA–3 (3/76)

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: September 21, 1980

Project Title: Demonstration: Filtration of Waste Stabilization Pond Effluents

Project No: E-26-641 (Continuation of A-1923 which began 11/17/76)

Project Director: Dr. T. F. Craft

Sponsor: Coastal Plains Regional Commission; Charleston, SC 29401

Effective Termination Date: 9/1/80

Clearance of Accounting Charges: - - -

Grant/Contract Closeout Actions Remaining:

None

_ Final Invoice and Closing Documents
_ Final Fiscal Report
_ Final Report of Inventions
_ Govt. Property Inventory & Related Certificate
_ Classified Material Certificate
_ Other _____

Assigned to: Nuclear Engineering (School/Laboratory)

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Project File (OCA)
Project Code (GTRI)
Other Mr. C. E. Smith

CA–4 (1/79)

A-1923

DEMONSTRATION: FILTRATION OF WASTE STABILIZATION POND EFFLUENTS

by

T. F. Craft

Progress Report

Project A-1923

Sponsored by

Coastal Plains Regional Commission
215 East Bay Street
Charleston, S. C. 29401

The Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

May 17, 1977

FILTRATION OF WASTE STABILIZATION POND EFFLUENTS

Introduction

The objective of the subject work is to obtain field data on the general applicability of sand, authracite, and mixed media filters for upgrading the effluent from ponds to bring them in compliance with federal regulations concerning suspended solids.

Waste stabilization ponds are widely used in smaller communities, and have generally been found to be acceptable in terms of efficiency, cost, and upkeep. The promulgation of new federal regulations has produced a need for lower effluent suspended solids content than is usually obtained. As it is wholly unrealistic to consider abandonment of ponds as a treatment method, means for producing better pond effluents are needed.

Filtration is a general procedure for separating particulate matter from liquids, and is widely used in water treatment and, to a much lesser extent, in wastewater treatment. While there is seemingly no à priori reason that filtration of pond effluents will not work, the technique has not yet been demonstrated, and consequently no engineering data is available. The project has been undertaken to provide a demonstration and appropriate data.

Equipment Acquisition

The major item of concern has been (and is) the filter and its accoutrements. Specifications were drawn for the desired equipment, which included a complete set-up mounted on a trailer and including a generator for operation without regard to availability of an external power source. All bids were far too high, as the cost of the trailer was much higher than previously estimated.

Through a concerted effort and with the splendid cooperation of the Georgia State Agency for Surplus Property we obtained an eminently satis-

factory trailer. Although it was manufactured in 1954, the massive frame of this old surplus Air Force trailer is in excellent condition. Repairs were required on the brakes and lights, and all tires needed replacement, but when all costs are added, the total is less than 10% of the cost of a new trailer. A portable generator was also obtained from this same source, and again at a small fraction of the cost of a new unit.

The initial bids were all rejected and new bids were requested. The low acceptable bid was submitted by Davco-Defiance, Thomasville, Georgia and the order was placed. This supplier has so far been most cooperative in making slight changes in layout and design of the filter unit, and a very good result is expected.

Davco-Defiance has also agreed to mount the filter and generator on our trailer, so that the unit will be essentially ready to run when delivered. The initial delivery date was scheduled to be the first of May, but the rebidding caused delay. Presently the filter is to be completed May 12, with mounting and other final details to require 2 or 3 more days. The project director is planning to inspect the completed unit at Thomasville May 19.

Site Selection

With the assistance of representatives of the Georgia State Environmental Protection Agency, some 20 ponds were selected for consideration. The main technological aspects sought were that the pond is in "normal" operating conditions and that it is representative of a larger number of ponds. Imposed on these factors is the very practical matter of accessibility of the pond so that the large, heavy (about 32,000 lbs) filter unit can be moved in.

This latter consideration has eliminated those locations whose approaches include a narrow, rutted, steep incline, or (very frequently) a small bridge of unknown, but suspect capacity. Other practical limitations, particularly in the Atlanta area, have eliminated other sites. Houses are located quite

close to some of these ponds and the noise of a gasoline engine powered generator running all night would obviously be a nuisance.

Candidate locations in the Atlanta area were inspected with particular care, as a situation close to Georgia Tech was sought where initial start-up could be accomplished and data collected. If any problems arise, proximity to our home base will be very important as a matter of convenience and travel time.

A two-stage pond in Gwinnett County has been chosen for the initial site. It is located about 30 miles from the Tech campus, but is less than 2 miles from Interstate I-85. Paved roads lead to within a few feet of the fence surrounding the pond. There is obviously an advantage to a two-stage operation, as it will be possible to withdraw effluent from each stage, and thereby provide two sets of data from a single location. This pond receives no industrial wastes, and serves only a residential area and a grammar school.

Plan of Operation

The filter is expected to be delivered to the Gwinnett County site before the end of May, and operations will begin immediately. Samples will be collected at frequent intervals and transported to Tech for analysis. Analytical data collected by the county will also be obtained and utilized.

It is not possible at this time to determine just how long it will be necessary to work at the initial location, but it is estimated to be about 6 weeks. If things work out in an easy fashion, the time could be somewhat less. The second location for operation is at Monroe, Georgia, where the multi-cell pond arrangement includes aerators in the first cell. Subsequent locations will be toward the south, with the expectation of eventually reaching the Brunswick area.

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

OFFICE OF
THE
COMPTROLLER

July 24, 1980

Mr. McIver Watson, Program Officer
Costal Plains Regional Commission
215 East Bay Street
Charleston, S.C. 29401

Dear Mr. Watson:

Enclosed is the Final Fiscal Report for Grant No. 10740003 covering the period January 1, 1979 through May 1, 1980.

If you have any questions or require additional information, please let us know.

Sincerely,

David V. Welch, Manager
Grants and Contracts Accounting

DVW/BITS/jb
Enclosure
cc: Dr. T. F. Craft
Dr. L. E. Weaver
Mr. E. E. Renfro
Mr. O. H. Rodgers
File E-26-641

DISTRIBUTED ON 7/21/80

E-26-641

GEORGIA INSTITUTE OF TECHNOLOGY
GRANT NO. 10740003
FINAL FISCAL REPORT
1/1/79 - 5/1/80

	SPONSOR	GRANTEE	TOTAL
Personal Services	$ 55,544.13	$ 4,650.17	$ 60,194.30
Retirement	5,069.90	443.50	5,513.40
Materials & Supplies	8,285.40		8,285.40
Travel	4,295.26		4,295.26
Capital Outlay	19,090.24		19,090.24
Consultants	160.62		160.62
Overhead (68% of P.S.)	37,770.45	3,162.11	40,932.56
	$ 130,216.00	$ 8,255.78	$ 138,471.78

DEMONSTRATION: FILTRATION OF WASTE STABILIZATION POND EFFLUENTS

by

T. F. Craft

Annual Report

Project A-1923-000

Sponsored by

Coastal Plains Regional Commission
215 East Bay Street
Charleston, S. C. 29401

The Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

November 17, 1977

DEMONSTRATION : FILTRATION OF WASTE STABILIZATION POND EFFLUENTS

Summary Edition

by

T. F. CRAFT
Georgia Institute of Technology
Atlanta, Georgia

for

The Coastal Plains Regional Commission
Charleston, South Carolina

1979

LEGAL NOTICE

Demonstration: Filtration of Waste Stabilization Pond Effluents

Introduction

An increasing public awareness of the hazards of polluted water and the benefits of clean water is evident in the United States and in other highly developed countries. This has led to increased emphasis on the abatement and/or prevention of water pollution. Regulatory agencies are following their legislative mandates to insure that lakes and streams become, and remain, clean enough for their intended use. Regulations on the quality of the water that is released to the environment have become increasingly stringent over the years, and good wastewater treatment practices are necessary to meet the requirements.

The treatment and disposal of wastewater presents problems for communities of all sizes, but particularly for smaller communities (populations up to a few thousand) with their limited financial resources. The typical small town does not have easy access to a large river, but must rely on some nearby creek or stream for disposal of wastewater. The problem becomes more difficult when the size or assimilative capacity of the available stream is insufficient to accommodate the quantity of wastewater being produced. It then becomes necessary to either provide a suitable level of treatment to meet the applicable standards or find some alternate means of disposal. Ponds are one possible solution to this problem.

The advantages of waste stabilization ponds lie in their simplicity of design, construction, and operation, and their relatively low cost. In spite of their apparent simplicity, ponds can produce a high degree of stabilization. Actually, the processes that occur in ponds are quite complex, and it is only through continuing scientific and engineering research that we have reached our present understanding of the fundamental biochemical reactions and biological relationships that occur in waste stabilization ponds.

In recent years there has been an increasing emphasis on wastewater treatment, and at present the Environmental Protection Agency regulations establish a maximum BOD_5 of 30 mg/l and a maximum suspended solids of 30 mg/l for all municipal effluents. Under ordinary conditions, the effluent of many ponds fails to meet these limits, particularly with respect to suspended solids. In typical pond effluent the solids are mostly algae which are generated by the normal functioning of the pond.

The work summarized here was undertaken to explore the various aspects of the use of porous media filters for the removal of suspended solids from waste stabilization pond effluent in order to improve beyond

reproach the quality of the effluent. At the time this work was begun, the limit on suspended solids content of municipal effluent had been established at 30 mg/l. Since that time, however, the rules and regulations have been changed so that some smaller ponds are no longer required to meet this limit. These possible exceptions to the general rule do not lessen the need for economically feasible methods for reduction of suspended solids in effluents. Present philosophy in the area of wastewater treatment is to produce the best results possible and it is believed that the trend toward more stringent requirements with few, if any, exceptions is not likely to be soon reversed.

Methods and Procedures

There are a number of different methods for upgrading pond operations to increase effectiveness and reduce suspended solids and BOD in the effluent. Fundamental differences can be produced through process design, physical facility design, hydraulic considerations, aeration, detention time, loading, and other parameters. But other possibilities which do not require extensive or complete reconstruction of an existing facility are available and are worthy of consideration. As the majority of the suspended solids found in pond effluent in the area of the Coastal Plains Regional Commission consist of algae, the direct approach to the problem involves algae removal. It is to be noted that algae are a part of the biological system of ponds, and their presence is a normal and necessary situation. The problem is therefore not to reduce algae concentrations in the pond, but rather to keep algae in the pond, or at least minimize their escape in the effluent.

Figure 1. Filter In Operation at Hazlehurst, Georgia

At least fourteen different strategies for algae removal have been suggested and investigated to some extent. Table I lists these systems and provides an estimate of the performance to be expected in full scale operation. It is seen that direct filtration without any coagulant is not particularly effective, but if filtration is preceded by a coagulation treatment, excellent results can be obtained. Variations of this process were the subject of this study.

Table I. Estimated performance of algae-removal systems

System	Mean effluent SS,[a] mg/l
Microstraining	>60
Direct filtration without coagulants	>60
In-pond removal—series arrangement, continuous discharge	>30
In-pond removal with chlorination[b]	>30
Submerged rock filter[c]	<30
Centrifuge	<30
Intermittent discharge lagoons[d]	<30
Aquaculture	<30
Overland flow	<30
Coagulation-flocculation-sedimentation	10–30
Coagulation-flotation	10–30
Intermittent sand filtration	20
In-pond chemical addition to intermittent discharge lagoons[d]	<10
Coagulation-clarification followed by filtration	<10

[a]Assumes pond effluent suspended solids at 150 mg/l, except as noted.
[b]Accompanied with the release of BOD
[c]Tentative ranking—full scale testing to date is based on pond effluent suspended solids averaging less than 73 mg/l.
[d]May be limited to northern U.S. climatic conditions.

In some cases, the results of laboratory experiments cannot be translated directly to full-scale operations and an intermediate scale study is required. For this reason, the work described here was carried out in pilot scale, utilizing the largest filters and tank that could be reasonably transported on Georgia highways. The complete unit is shown in Figure 1 and consists of a heavy-duty trailer carrying two circular filters, each four feet in diameter, and a storage tank with a capacity of 2500 gallons. The intake pump, filter backwash pumps, air scour system, and chemical feed pumps could be powered by the engine driven generator mounted on the trailer or by an external electric power source. For operation of the unit, the trailer was positioned on the bank of the pond near the outlet structure. The submersible pump which supplied the filter was positioned at the outlet and effluent was pumped into the filter unit. This was satisfactory for investigative purposes, but permanent installations would have the filters placed at a low elevation so that gravity feed instead of pumps could be used. Studies were made at four Georgia locations: Duluth, Monroe, Hazlehurst, and Ashburn, and very similar results were obtained at all ponds.

A preliminary series of filter runs was made using sand, anthracite, and a combination of both. It was found that effective separation of algae from

water could be made only if the filter medium was very fine. This was due to the small size of the individual algal cells and their electrical charge which tends to prevent their agglomeration. The fine-grained sand which produced a very high degree of algae removal also produced a very rapid head loss, due to obstruction of the openings in the packed medium by the trapped particulates. This necessitated frequent backwashing of the filter which required more of the filtered water than would be practical.

Subsequent work therefore centered around the addition of alum and/or synthetic polymer prior to filtration. This technique resulted in the generation of floc or particle agglomerates which could be reaily removed by a rather coarse bed of filter sand or anthracite. Head loss increased more slowly, and backwash was required much less frequently than with finer filter medium.

Results

Most of the data collected during this study is summarized in the tables which follow, and each shows the conditions of the run along with the concentration of suspended solids in the filter influent and effluent. The chemical feed system consisted initially of a 25-gallon drum from which solution could be injected into the filter influent hose by an adjustable high-pressure feed pump. A second tank and pump were soon added to the system, however, in order to provide independent adjustability of the alum feed and the polymer. Some runs were made, however, with a single pump system injecting mixed solutions of alum and polymer.

The results achieved by use of alum alone are displayed in Table II. As a starting point, two runs are included here which involved no coagulant; the first, run 3-29, produced no change in suspended solids when the liquid passed through the anthracite filter. Some effect is indicated in run 5-3 where the liquid was passed through the dual-media filter. At this stage of the operation, the fine sand had been removed from the sand filter and all subsequent filtration involved the coarser media appropriate to

Table II. Filtration with Alum

Run	Suspended Solids mg/l Inf	Eff	Alum ppm	Flow ga/ft^2/min	Filter Medium
3-29	80	80	0	1.5	Anthracite
5-3	66	48	0	1.4	Dual
9-28	42	21	8	3.0	Dual
9-28	42	27	8	3.0	Anthracite
6-6	59	40	10	1.3	Sand
4-6	95	50	12	1.6	Anthracite
4-13	70	49	13	1.4	Sand
3-24	35	25	15	1.0	Anthracite
3-31	63	38	20	1.5	Anthracite
4-14	88	35	25	1.4	Sand
5-3	38	17	32	1.4	Dual
4-17	80	29	38	1.4	Sand
5-18	42	22	67	1.4	Dual

the coarse alum floc that was to be the normal type of matter to be captured in the filter. From the remaining entries in this table, it may be seen that the use of alum alone at the indicated levels of introduction always reduced the suspended solids level, but never produced the very low values that were later obtained from combinations of alum and polymer.

This is probably due to the manner in which the filter unit itself was constructed and operated. It appeared that the length of time between alum injection and actual filtration was much too short for maximum efficiency, and additionally put the entire floc load on the filter. At high flow rates it was noted that floc occasionally was visible in the washwater tank, indicating that the water had already passed through the filter before floc formation and growth was complete. There is also to be noted frequent instances of what appear to be inconsistent results, but in this case as with other biologically active systems the precise cause of variation is not readily attributable to a single factor. A case in point is a comparison of runs 9-28 and 5-18 where influent concentrations were identical. In this instance, a low alum feed and high flow produced the same effect as a much higher alum feed rate and lower flow rate,which is opposite to the effect normally encountered.

The use of a polymer as a filter aid in conjunction with alum and by itself was studied. A number of samples were obtained from several manufacturers, following detailed discussion of the project needs and the properties of the various polymers that are available. A series of preliminary tests of these polymers was carried out in the laboratory in a test filter which was constructed of a 4-inch diameter tube five feet in length. Dual media were installed, and a backwash arrangement was provided.

The experiments were performed by adding suitable quantities of the polymer to pond effluent that had been transported to the laboratory. The effectiveness of the polymer was judged by the solids content of the effluent, and by comparison with that of the influent. It was deemed necessary to use only pond water that was collected on the same day in order to correlate as closely as possible conditions in the laboratory and in the field. In general, the correlations were not very satisfactory, although there was a qualitative relationship. In several cases certain materials that showed promise in the laboratory were completely ineffective in the field. The products that were chosen for more extensive testing are listed in Table III.

Table III. Polymers Tested in Filtration Runs

Polymer	Manufacturer
Nalco 7103	Nalco Chemical Company
Nalco 7132	" " "
Nalcolyte 7105	" " "
Nalcolyte 7107	" " "
Nalcolyte 7134	" " "
Purifloc 31C	Dow Chemical Company
Magnifloc 581C	American Cyanamid Company
Magnifloc 1839A	" " "
Magnifloc 2535C	" " "

Table IV. Filtration with Polymer

Run	Suspended Solids mg/l Inf	Eff	Polymer	Feed ppm	Flow $ga/ft^2/min$	Filter Medium
5-9	75	51	C31	0.5-2	1.4	Sand
5-10	73	51	C31	2	1.4	Sand
5-10	58	56	1839A	1	1.4	Sand
5-11	81	62	1839A	5	1.4	Sand
5-8	97	84	2535C	5-10	1.4	Sand
5-5	109	55	2535C	1-4	1.4	Sand
6-30	71	45	7103	10	1.6	Anthracite
6-29	116	22	7103	19	1.6	Anthracite
7-5	127	72	7105	10	1.6	Anthracite
7-5	108	110	7105	19	1.6	Anthracite
5-6	202	218	7107	20	1.6	Anthracite
5-12	81	90	7107	20	1.5	Anthracite
7-13	38	27	7132	39	1.8	Anthracite
7-18	72	38	7134	40	1.6	Anthracite

To evaluate the possibility of rejecting a desirable material on the basis of laboratory studies that might be shown to lack proper correlation, a few additional polymers were run in the field in spite of their poor laboratory showings. In this type of situation the correlation was high— poor laboratory results gave poor field results. The results of some of the field tests with polymer alone are given in Table IV. The general range of concentration was usually about what the manufacturer suggested. Specific recommendations are seemingly seldom made with respect to feed levels, the usual practice being to select a material and then adjust to the minimum feed rate that will accomplish the desired result.

Nalco 7103, a pollution control coagulant recommended for use at a level of 2 to 50 ppm, showed a fairly satisfactory result in the laboratory and was therefore tested in the field. The best results obtained are shown in Table IV as runs 6-30 and 6-29. In other runs, from influents whose suspended solids levels ranged from 40 to 130, it was possible to obtain effluents in the 20-40 range, with an occasional value even lower, when 7103 was added at rates up to 50 ppm. When tested in combination with alum, results were not appreciably better, even at feed rates of alum up to 50 ppm. Experiments and tests involving Nalcolyte 7134 gave similar

Table V. Filtration with Alum and Polymer

Run	Inf	Eff	Alum ppm	Polymer	Polymer ppm	Flow	Filter Medium
5-22	28	17	60	C31	0-11	1.4	Dual
5-23	28	15	15	C31	3	1.4	Dual
5-24	52	24	15-30	C31	3-6	1.4	Dual
5-25	28	7	24	1839	0.5	1.0	Dual
5-30	51	20	24-48	1839A	0.5-1	1.4	Dual
5-17	41	33	12-50	1561C	1-5	1.4	Dual
7-12	120	97	10	7107	4	1.5	Anthracite

results. The results from use of other products tested in the laboratory and field are given in the same table.

The enhancement of results when alum is used in combination with some polymers is shown by comparison of Table V with Table IV. With the exception of run 7-12, the alum addition gives a final result significantly lower than the polymer alone. Runs 5-25 and 5-30 show satisfactory results, but in this instance the enhancement is probably due to the alum counteracting the anionic polymer and thereby destabilizing the algae, so that coagulation and subsequent removal by filtration can take place.

Of the various polymers that were used during this study, the most effective material found was Magnifloc 581C. Consequently, many runs were made with this material both alone and in combination with alum. Table VI shows the results of adding 581C alone at rates of 4 to 32 ppm.

Table VI. Filtration with Magnifloc 581C

Run	Suspended Solids mg/l Inf	Eff	581C ppm	Flow	Filter Medium
9-21	108	50	4	1.4	Dual
	108	56	4	1.4	Anthracite
8-2	80	22	4.5	2.0	Dual
	80	30	4.5	2.0	Anthracite
8-3	86	38	4.5	2.2	Dual
	86	39	4.5	2.2	Anthracite
7-21	63	29	7	1.2	Anthracite
8-7	106	40	7	2.0	Dual
	106	46	7	2.0	Anthracite
7-25	48	16	10	1.0	Anthracite
5-12	90	52	10	1.0	Dual
	90	53	10	1.0	Anthracite
5-15	79	43	10	1.5	Dual
	79	62	10	1.5	Anthracite
8-9	80	22	12	1.8	Dual
	80	27	12	1.8	Anthracite
7-28	47	14	13	2.1	Dual
	47	20	13	2.1	Anthracite
10-4	34	8	24	1.3	Dual
	34	8	24	1.3	Anthracite
7-20	64	7	14	1.3	Anthracite
8-7	152	35	14	2.0	Dual
	152	55	14	2.0	Anthracite
9-21	153	32	16	1.4	Anthracite
8-1	58	13	22	2.1	Dual
	58	18	22	2.1	Anthracite
9-20	88	33	26	1.7	Dual
	88	38	26	1.7	Anthracite
7-19	63	1	27	1.6	Anthracite
10-3	40	7	29	3.0	Dual
	40	7	29	3.0	Anthracite
9-26	68	56	32	2.0	Dual
	68	63	32	2.0	Anthracite

There is a considerable variation in the suspended solids content of the effluents, but there is generally a good solids reduction, and at times an excellent reduction.

The situation improves significantly when the 581C is used with alum. In the tabulation of results using this combination (Table VII), it may be seen that only two effluent values exceed 28 mg/l, and one of those (anthracite filtration, run 9-29) is offset by the lower value of the same liquid when filtered through dual media. It therefore appears that almost any combination of alum and 581C in the range listed would provide a satisfactory outcome for regular operations. In actual practice, incremental adjustment of the feed of both alum and polymer could lead to determination of the optimum combination to achieve the required level of suspended solids.

Actually, the solids contents of effluent can be reduced to almost any value desired if sufficient treatment chemicals are added. Figure 2 displays the results of adding massive amounts of both alum and 581C. Such dose rates would be very expensive to maintain on a large scale, but they do produce exceptionally good effluent. In fact, these levels are much lower than even the more restrictive regulatory mandate, and ordinarily there would be no need to produce effluent of quality this high.

Conclusions

Throughout these studies it has been clear that the length of filter runs is more dependent, for a given set of circumstances, on the total quantity of water filtered than on the rate of filtration. Higher flow rates tend to drive some particulate matter through the filter medium, but the total amount of solids trapped in the filter remains fairly constant. From this it follows that process design which minimizes the delivery of solids to the filter is highly advantageous.

The concept of coagulation followed by a period of sedimentation prior to filtration has much to recommend it. The destabilization of algae by

Table VII. Filtration with Alum and Magnifloc 581C

Run	Suspended Solids mg/l Inf	Eff	Alum ppm	581C ppm	Flow	Filter Medium
6-7	34	28	10	0.5	1.3	Sand
6-21	55	18	8	1	1.5	Dual
6-9	38	4	20	1	1.4	Sand
6-13	107	63	8-16	1.2	1.5	Dual
6-22	84	11	11	1.7	1.0	Dual
6-20	34	2	13	2	1.5	Dual
5-16	37	15	16	3	1.4	Dual
	37	15	16	3	1.4	Anthracite
6-23	81	28	13	6	1.0	Dual
6-27	33	15	20	9	1.2	Anthracite
6-26	39	17	20	9	1.5	Anthracite
10-6	38	7	10	16	1.5	Dual
	38	7	10	16	1.5	Anthracite
6-27	65	4	40	18	1.2	Anthracite
6-28	133	16	16	21	1.0	Anthracite
9-29	73	26	8	31	3.0	Dual
	73	42	8	31	3.0	Anthracite

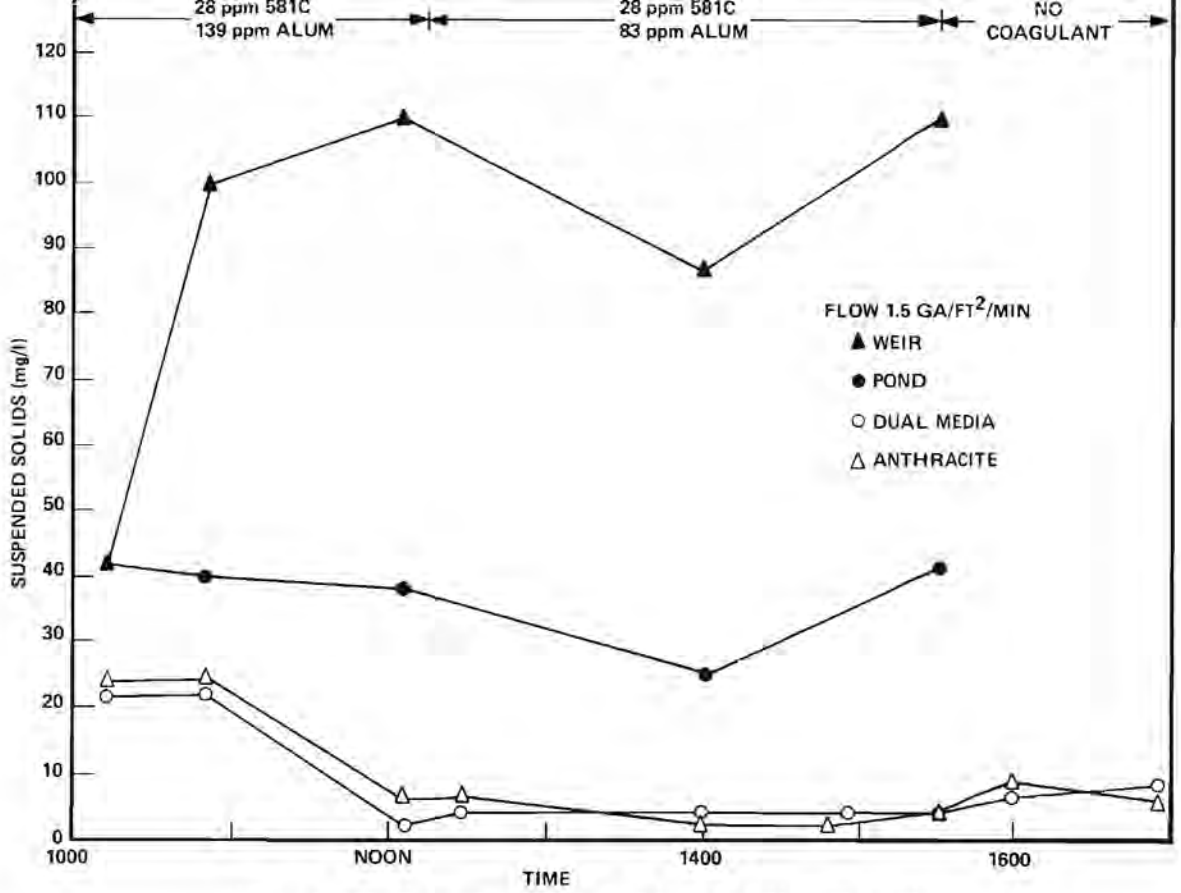

Figure 2. Filtration with High Dose of Alum and Magnifloc 581C

alum or alum-polymer has been shown to be a very simple and straightforward means for inducing a liquid/solids separation through gravitational sedimentation. In a system designed to preserve a state of quiescence during the settling stage, the outflowing supernatant should contain very little floc or other suspended matter and long filter runs should be routine.

An additional refinement of the process would be to include a short period of gentle mixing to provide time for full development of the floc and maximum entrapment of suspended matter prior to the period of settling. In this respect, the treatment facility would be quite similar to a water treatment facility in general features, but would be operated to produce acceptable effluent at minimum cost rather than to produce the absolutely highest quality effluent possible.

The results of this investigation show quite clearly that filtration preceded by flocculant addition is a viable method for reducing the suspended solids concentration in waste stabilization pond effluents. Alum alone may be used, but it appears advantageous to add a small amount of polymer along with the alum, as this produces satisfactory results with an overall reduction in cost of chemicals. The action of a particular polymer cannot be predicted very accurately, and it is believed that in most instances trials will be necessary to evaluate a selected product and to determine the optimum dose rate.

It is concluded that the best arrangement for coagulation/filtration processes would include a period of flocculation and sedimentation following addition of chemicals. In this situation, most of the floc would never reach the filter, and runs of almost any desired length could be obtained. The settled sludge could be returned to the pond, preferably in a widespread manner. The relatively small volume of sludge produced should not interfere with pond operation for a period of at least several years.

DEMONSTRATION: FILTRATION OF WASTE STABILIZATION POND EFFLUENTS

by

T. F. Craft

Annual Report

Project A-1923-000

Sponsored by

Coastal Plains Regional Commission
215 East Bay Street
Charleston, S. C. 29401

The Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

November 17, 1977

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Demonstration: Filtration of Waste Stabilization Pond Effluents

Introduction

Waste stabilization ponds occupy a unique place among wastewater treatment processes. They are simple to design, simple to construct, simple to operate, and are relatively inexpensive. Consequently, ponds are widely used, particularly in smaller communities where land is available and skilled wastewater treatment plant operators are scarce. Ponds provide a very effective treatment with a high degree of reduction in soluble biodegradable organics, a reduction in nutrient elements, a reduction in calcium, magnesium, and heavy metals, a low energy demand, and a high degree of flexibility.

There are, however, some aspects of wastewater ponds that are less than ideal. Odors may be occasionally evident at certain seasons, but the major current topic of concern is the suspended solids content of typical pond effluents. The majority of the solids consist of algae, which are formed during the normal functioning of the pond ecosystem. It can be argued that algae are definitely more acceptable than typical influent solids, but still present potentially significant problems. These include interference with the disinfection process, depletion of dissolved oxygen in the receiving waters due to degradation of cells, and progressive stream fertilization due to nutrient recycle. It is for reasons of this sort that the present federal regulations limit the suspended solids content of these effluents to 30 mg/l, averaged over a 30-day period. Ponds in the southeast typically produce effluents with suspended solids considerably above this limit, and means are needed to reduce these values to an acceptable level.

The use of multicell designs helps to reduce suspended solids levels, but most existing ponds are not readily amenable to major redesign, even if costs are not prohibitive. It therefore appears that other processes are needed which can bring effluent quality within the established limit. Filtration is one means by which solids can be separated from liquids, and the application of this technique to pond effluents is the subject of the present project. Algae are difficult to filter out of water because they are quite small in size (2-20 microns), they have a specific gravity very close to that of water, and their concentration in the water is low. It appears that optimization of filter factors (flow rate, filter media, back wash cycle and so forth) may provide solids reduction to the desired level.

Equipment

The major item of equipment required for the work was a filter of appreciable size that can be transported to various ponds for evaluation. A survey of available off-the-shelf designs revealed no single unit that would meet our criteria of operation and size. The limitations for vehicles on Georgia highways are 8 feet in width and 13½ feet in height, and it was considered highly desirable to be within these limits to avoid the necessity of obtaining a special permit for each move.

Most available units are rather tall, height being no particular consideration in permanent installations. This situation was also complicated by the need to mount the unit on a flat bed trailer which stood some 57 inches high. The trailer had been obtained through the Georgia State Agency for Surplus Property, whose personnel went to considerable length to demonstrate how helpful they could be. The trailer was one that had belonged to the Air Force. Although it was manufactured in 1954, its massive frame is in excellent condition. It was necessary to repair the brakes and lights,

and to replace all tires, but the net result is a unit that should be serviceable for an indefinite period.

The low acceptable bid on the filter was submitted by Davco-Defiance, Thomasville, Georgia, and the order was placed. There was some delay caused by discussion and implementation of slight changes in layout and design of the filter unit with the result that delivery was not made until June. Figure 1 is a print of the final configuation of the filter and Figures 2 and 3 are views of the filter itself.

We obtained a portable generator from the Surplus Agency and had it mounted on the trailer with the filter. This was to provide flexibility to operate in locations away from power lines, but has thus far been the source of considerable difficulty. The gasoline engine which powers the generator has been difficult to start, although it runs quite well once it is in operation. It is planned to have the engine overhauled at the first opportunity. In the meantime, Gwinnett County Water and Sewerage System has allowed us to use a new trailer-mounted generator that they recently obtained. This unit has its own idiosyncrasies, but has presented no significant difficulties.

The other major equipment item associated with the filter is hose. As presently arranged, one influent line is used, but six effluent lines are required for backwash, overflow, outlet, and drain purposes. Heavy duty 4" flexible hose costs about $3.50 per foot plus fittings but the Surplus Agency was able to supply a number of 40 foot lengths complete with fittings at a very nominal cost. It is believed that our stock of this hose is sufficient for any needs that may arise during the course of this project.

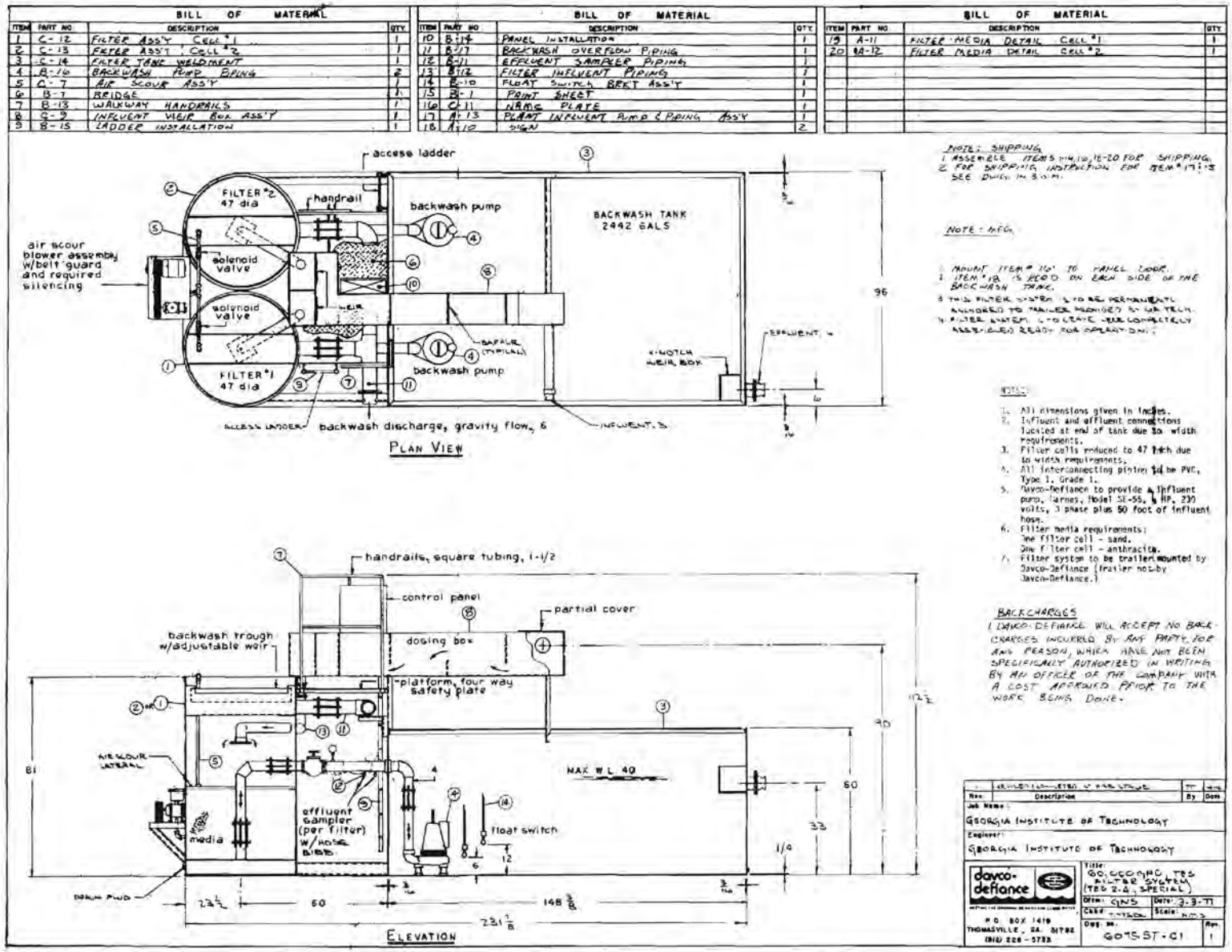

Figure 1. Plans of Filter System.

Figure 2. General View of Filter in Operation.

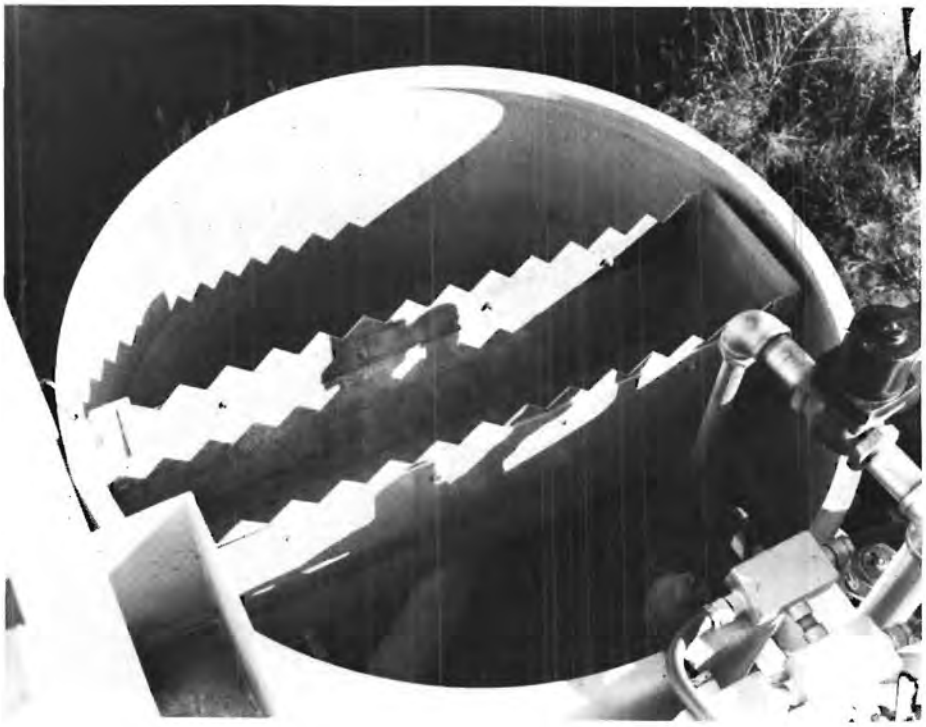

Figure 3. Top View of Filter Showing Backwash Trough with V-Notch Weirs.

Site Selection

After considerable investigation of waste stabilization ponds in the Atlanta area, it was decided that the Clayborn Manor Pond of Gwinnett County was best suited for our purposes. The only apparently major disadvantage is the location—some thirty miles form the Georgia Tech campus, but it is only two miles from an Interstate Highway and easily accessible. It later developed that the lack of 3-phase electrical power was a serious deficiency.

As shown in Figure 4, the arrangement consists of two basins. The first has a nominal surface area of 3.45 acres and the second 1.47 acres. It was thought that the availability of effluent from two different ponds at a single location would be advantageous, but it was later discovered that the suspended solids content of both ponds was about the same.

The area served by this facility includes a large elementary school, several churches, and family residences. No commercial or industrial wastes are routed to these ponds.

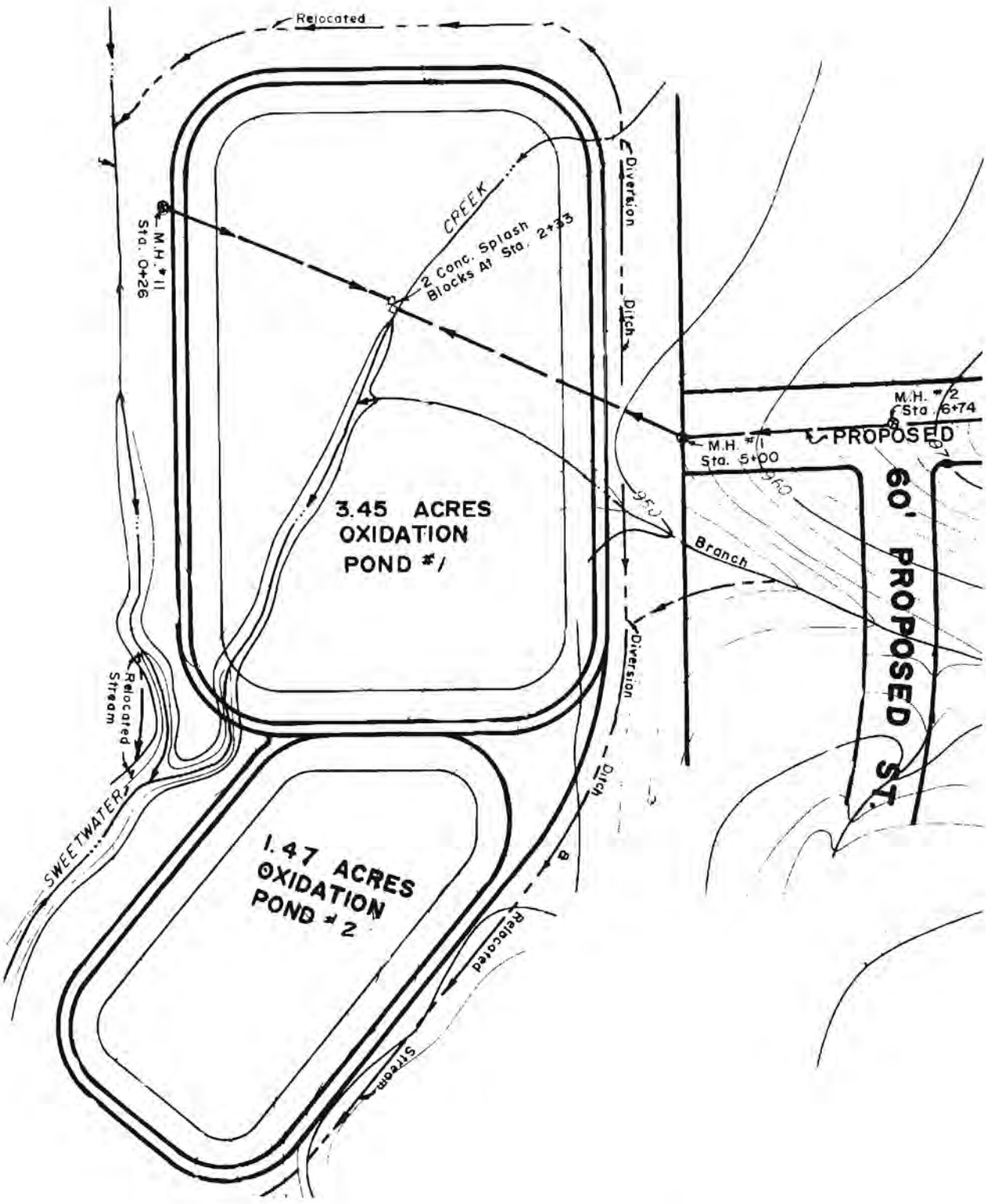

Figure 4. Map of Clayborn Manor Ponds

Operation

The start-up phase of the filtration operation has been extraordinarily plagued with difficulties. As noted above, the generator gave trouble at the beginning and intermittently thereafter. Most of the smaller replaceable items associated with the generator engine have now been replaced, and it is believed that most of the problems in this area have finally been solved.

Problems with the filter itself have been numerous and diverse. As received, the polarity of the motor driving the air blower was reversed, with the result that water and anthracite were drawn from the filter into the blower, which promptly froze due to rust formation. The blower was replaced and the polarity corrected; subsequent operation of the blower has been satisfactory.

Proper flow control was not provided in the original design, but was finally achieved by placing a throttling valve in the influent pipe, and two exit valves in the inlet box. The throttling valve provides a coarse regulation and the other valves allow fine adjustment of the flow to the filters. Vee-notched weirs are situated at the filter inlets, and provide a means for accurately determining flow rates. Hook gauges were made from small diameter brazing rod, and are used to measure the water level at the weir. The flow rate can then be read from a calibration chart.

The backwash cycle for the filters consists of an initial air scour a period to allow the medium to settle, and then water flows from the storage tank up through the filter medium, overflows into the backwash trough, and exits back into the pond some 80 feet from the influent pump which supplies the filters. The backwash sequence can be initiated by settings on a 24 hour timer, by switches which detect excessive head loss,

or by a manually operated switch. Once begun, the whole sequence is automatic, washing one filter and then the other.

A problem was encountered, however, with the automatic backwash cycle in which the second filter was washed less than the first, if at all. After much experimentation, consultation, and two service calls, it was discovered that the motor of the sequencing timer was turning faster than specified. When a motor of the proper speed was installed, the problem was solved.

In the filtration mode, the operation is as follows:
Influent is pumped from the pond outlet by a submerged pump. After passing through the throttling valve, flow enters the inlet box where any excess is returned to the pond through outlet valves. The remainder of the flow passes over the weirs into the two filter units, down through the filtration media, and into the backwash tank. Once the tank is filled, the overflow is returned to the pond. Filtration continues in this manner until interrupted by backwash operation or shut-down.

Samples of both influent and effluent are collected at selected intervals for analysis. The analytical procedure consists essentially of weighing the residue obtained by filtration through a filter paper of a known volume of the sample in question. The exact details of thr procedure are carried out in accordance with instructions given in Standard Methods*. Samples are routinely filtered in the field using a portable vacuum pump but are returned to the laboratory for drying and reweighing.

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* "Standard Methods for the Examination of Water and Wastewater", 13th Edition, American Public Health Association, 1740 Broadway, New York, NY 10019, 1971.

Data and Discussion

The suspended solids content of the filter influent has been found to fluctuate very rapidly over a wide range. It seems evident that the pond contents are not evenly distributed, and wind and water motions are responsible for readings such as 30 mg/l within an hour of a reading of 80 mg/l. There is no obvious means to control this fluctuating solids concentration, and it is believed that the most reliable results are obtained from averaging the values obtained over a period of time. A corresponding fluctuation is sometimes observed in the filtrate, but is generally much less pronounced. Typical data collected using the sand and anthracite supplied with the filter were plotted and are shown as Figure 5. The particle size distribution of the sand was determined by screening, and was found to be as shown in Figure 6. The effective size of 0.76 mm was far too large to capture algae which are quite small. Instead of replacing the entire sand bed, the particle size distribution was shifted to the smaller end by the addition of "Minus 30 Sand Blasting Sand." The resulting particle size distribution of the thoroughly mixed bed has an effective size of 0.2 mm as shown in Figure 7. Although this is not a natural distribution, it works much more effectively than the initial bed.

Figure 8 illustrates the type of result obtained after the fine sand had been added. The fluctuation of values for the influent is typical, and in this instance it is assumed that the average value is in the vicinity of 120 mg/l. The effluent curves are representative of filtration curves usually observed in porous media filtration. Filtrate quality improves slightly during the early period following backwash, remains at a fairly constant point for a period of time, and then gradually decreases in quality. The end point of any filter run is reached when the filter is saturated, and

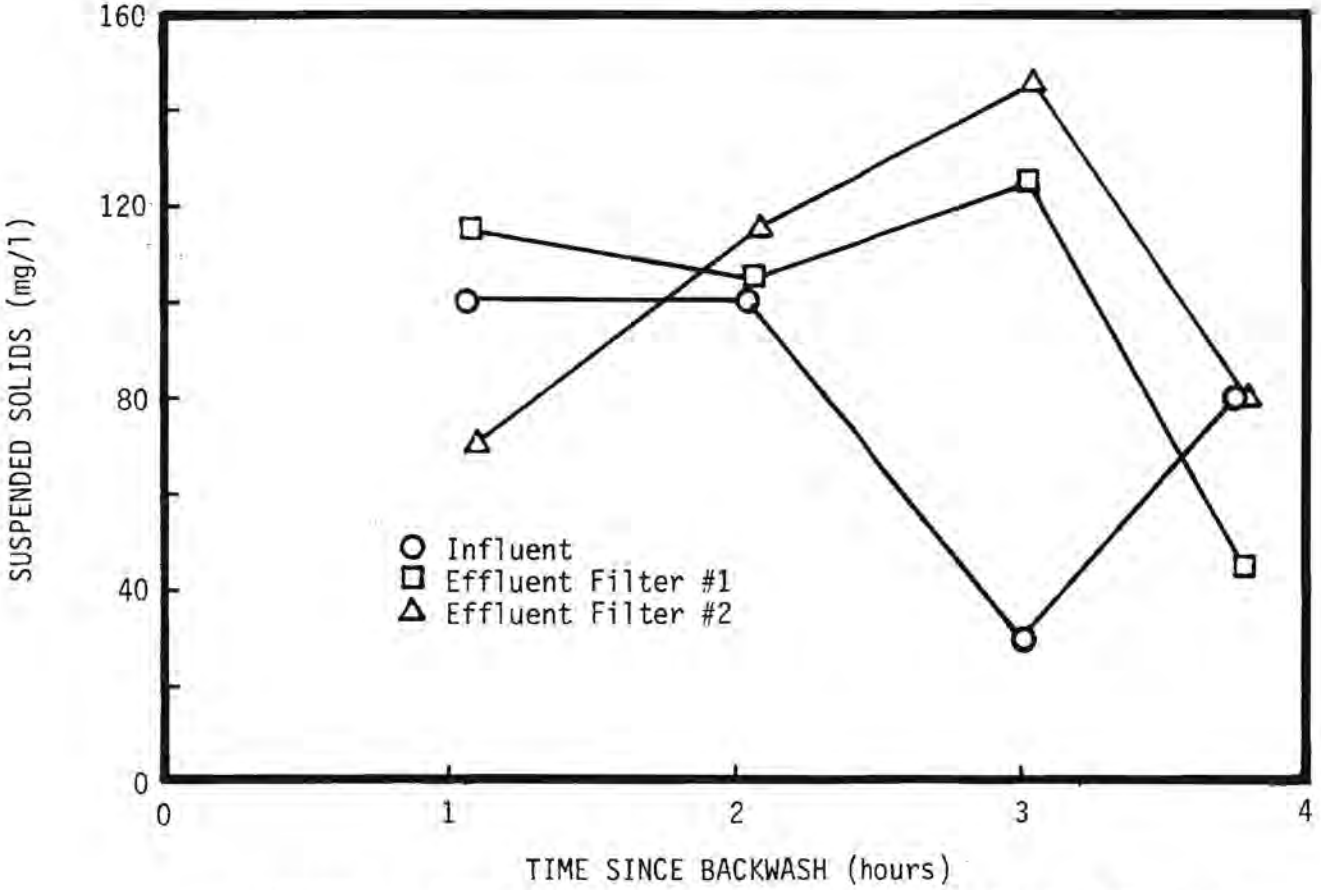

Figure 5. Suspended Solids Concentration of Filter Influent and Effluents.

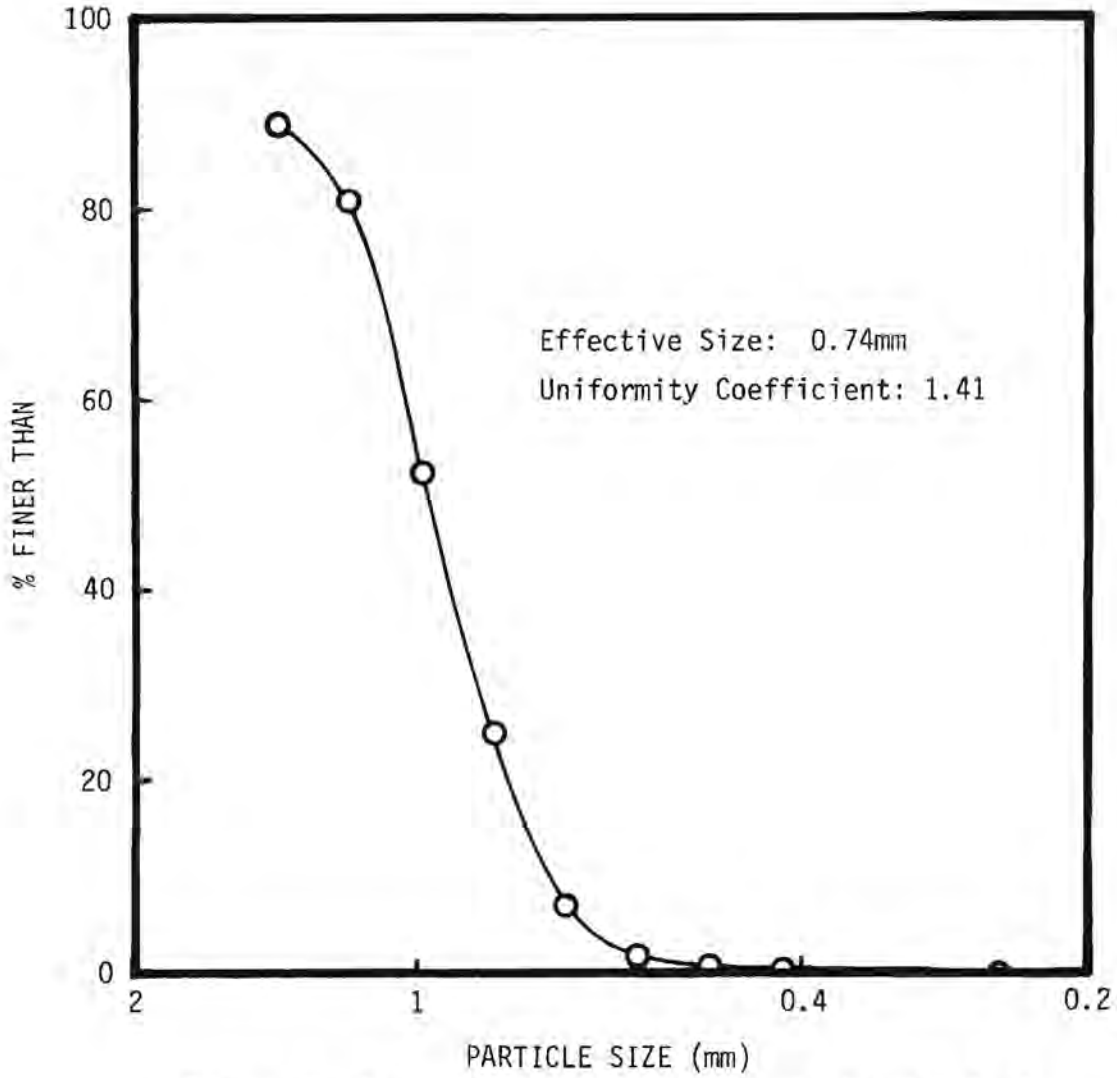

Figure 6. Particle Size Distribution of Initial Sand.

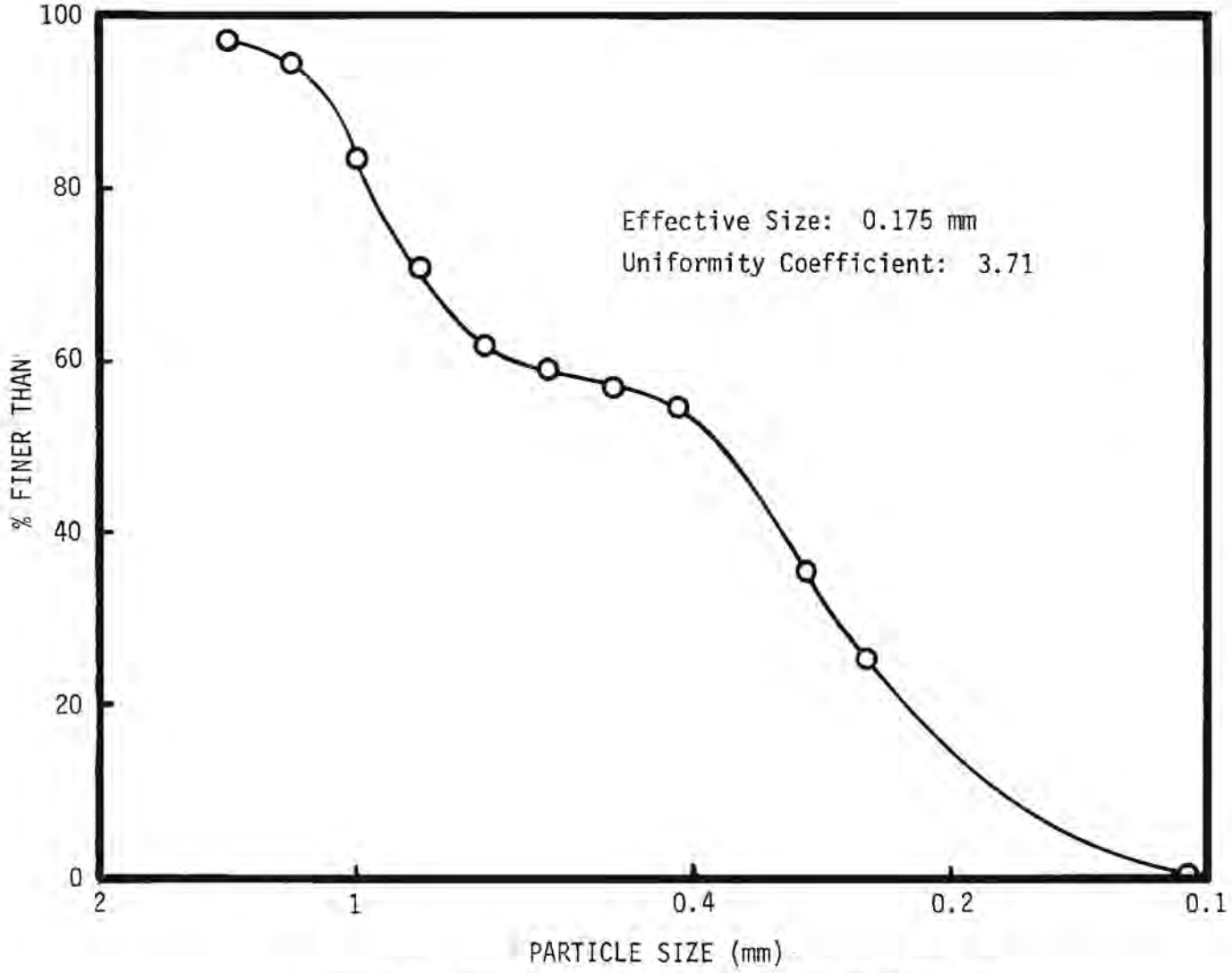

Figure 7. Particle Size Distribution of Sand Bed After Adding "Minus 30 Sand Blasting Sand".

the quality of the effluent is the same as that of the influent. Alternately, the filter may become completely clogged so that no water passes through. In the present work, filtration is interrupted before either of those conditions occurs.

The results of filtration runs such as that of Figure 8 are satisfactory from the standpoint of solids removal, but the flow rate is low, and quality of the effluent worsens after only a short period of time. The problem, therefore, is to increase the flow rate and the length of the filter runs without degradation of the effluent quality. Increasing the flow rate generally increases the solids content of the filtrate. Figure 9 illustrates this effect. Clearly, other approaches will be required to achieve the desired result.

Plans for Future

It is planned that a smaller particle size of anthracite will be tested, as the present size does not achieve the solids removal sought. It is interesting to note, however, that the rather coarse anthracite is about as effective as the very fine-grained sand that has been used. An evaluation of dual media and possibly mixed media is planned. The other major approach to be tried will involve the use of a coagulant. A chemical feeder will be used to add a small constant flow of the selected reagent from a small storage tank. Lime, alum, and various polymers are candidate compounds. Typically they will be used in low concentrations in the effluent so that relatively small quantities will be required.

It is planned to move the filter in the near future to the waste stabilization pond of Monroe, Georgia. This site is supplied with electrical power, and the filter can then be operated on a 24 hour, continuous schedule.

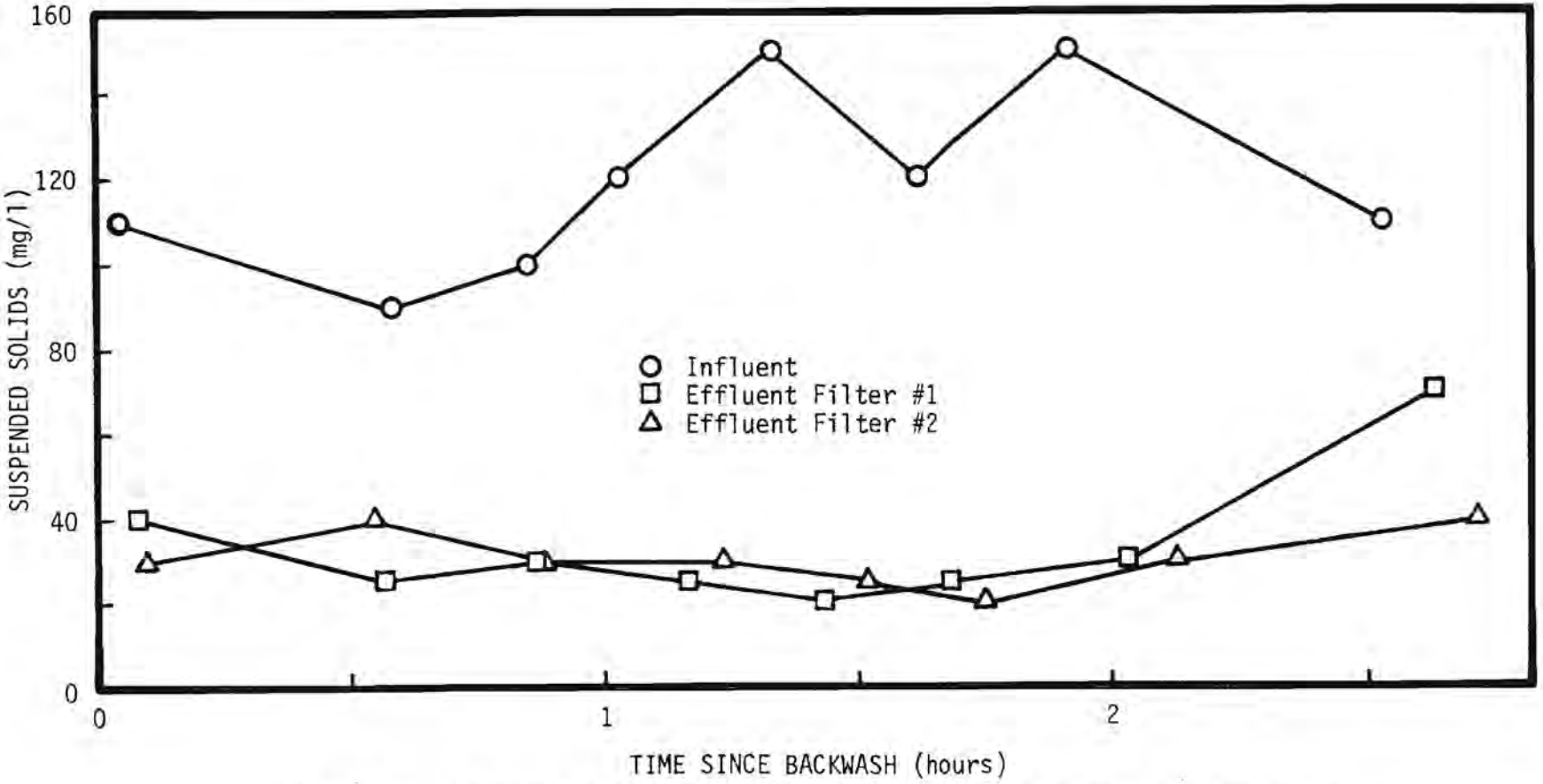

Figure 8. Suspended Solids Concentration of Filter Influent and Effluents.

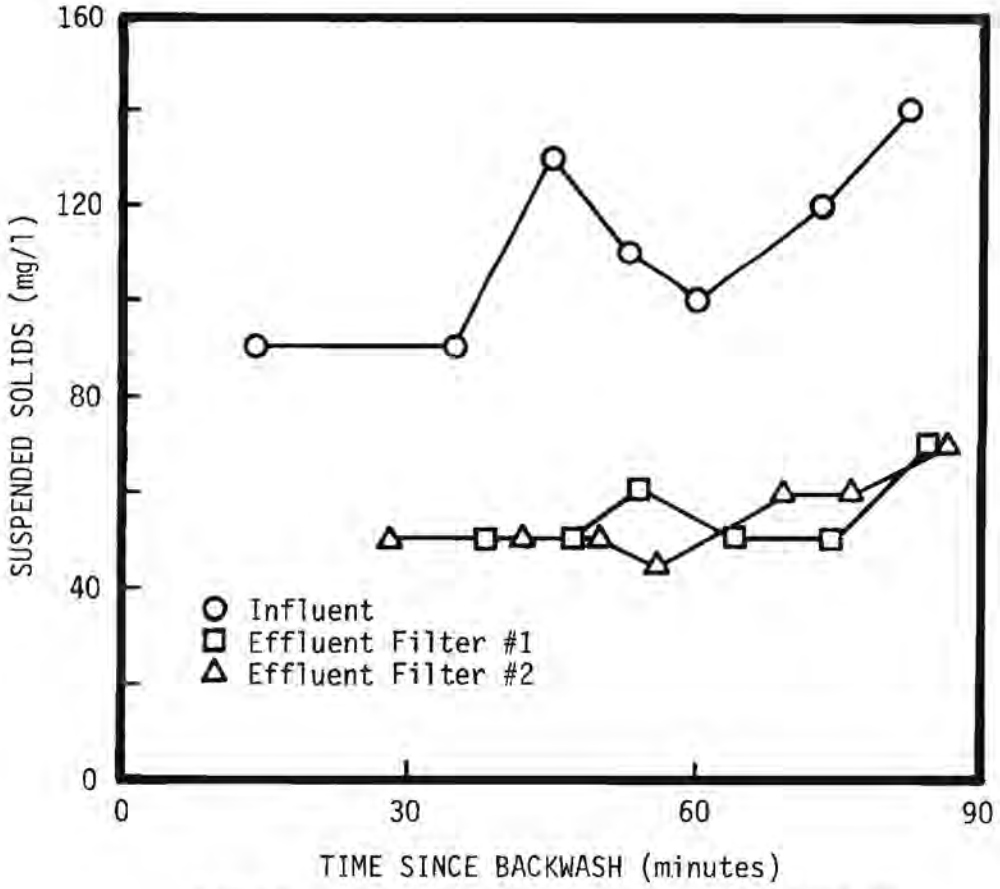

Figure 9. Suspended Solids Concentration of Filter Influent and Effluents.

SCHOOL OF NUCLEAR ENGINEERING

Atlanta, Georgia 30332 (404) 894–3720

November 9, 1979

Mr. McIver Watson
Coastal Plains Regional Commission
215 East Bay Street
Charleston, South Carolina 29401

Dear Mr. Watson:

Enclosed are two copies of the report "Demonstration: Filtration of Waste Stabilization Pond Effluents" which are submitted in fulfillment of the requirements of CPRC Grant No. 10740003. These are intended to serve as the official copies "of record" but will be followed by an abridged version more suitable for broad distribution. The shorter report will be forthcoming according to our previous general discussions with exact details still to be determined.

It has indeed been a pleasure working with you on this project, and I look forward to the possibility of additonal work in the not-too-distant future.

Yours truly,

T. F. Craft, PhD
Senior Research Scientist

E 26-641

DEMONSTRATION: FILTRATION OF WASTE STABILIZATION POND EFFLUENTS

DEMONSTRATION: FILTRATION OF WASTE STABILIZATION POND EFFLUENTS

by

T. F. Craft

Final Report

CPRC Grant No. 10740003

Georgia Tech Project E-26-641

Sponsored by

Coastal Plains Regional Commission
215 East Bay Street
Charleston, S. C. 29401

School of Nuclear Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332

November 17, 1979

Acknowledgements

A number of extraordinarily cooperative people have made significant contributions to the work reported here. The project officer of the Coastal Plains Regional Commission, Mr. McIver Watson, has been patient and understanding when troublesome problems have arisen and has given full support throughout. Personnel of the Georgia Agency for Surplus Property scoured the region for major items that were needed: a trailer, generator, tires, and hoses. In addition, they supplied many small but essential items. For efforts above and beyond the call of duty, thanks to Messrs. Jason Long, Harold W. Fendley, and James T. Spratlin.

A succession of gracious hosts was encountered at the various field locations where operations were carried out. Mr. David Van Landingham, Director of the Water Pollution Control Department of Gwinnett County, not only welcomed us to one of his ponds, but loaned us a brand new generator for an extended period while our regular generator was being repaired. Mr. John T. Briscoe, Superintendent of the Water, Light, and Gas Commission of Monroe, saved us untold hours of effort by installing a power line directly to the filter. This allowed continuous operation for extended periods. Sincere appreciation not only for this, but also for revealing the location of one of the fine eating places in this area. At Hazlehurst, Mr. Jerry Fisher, Superintendent of Water, provided a very warm welcome along with a crew to unload and later load the numerous hoses involved. He and his men continued to check on our operations at odd hours, providing the confortable feeling that help was near if needed. Thanks also to Mr. J. I. Youngblood, mayor of Ashburn, for assistance in the midst of his very busy schedule.

At the Georgia Forestry Commission, cooperation is genuine. Several people were involved in hauling the trailer around the state, and special appreciation is expressed to Mr. Ray Shirley, Director, Mr. Al Smith, Chief, Forest Administration, Macon, and Mr. James M. Tidwell, Jr., District Forester, Ashburn.

Special thanks also to Mrs. Ruth Salley and Mrs. Julia Rankin of Georgia Tech for their unflagging efforts in turning a mass of semi-legible hand-written pages into a report.

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I. Introduction

An increasing public awareness of the hazards of polluted water and the benefits of clean water is evident in the United States and in other highly developed countries. This has led to increased emphasis on the abatement and/or prevention of water pollution. Regulatory agencies are following their legislative mandates to insure that lakes and streams become, and remain, clean enough for their intended uses. Regulations on the quality of the water that is released to the environment have become increasingly stringent over the years, and good wastewater treatment practices are necessary to meet the requirements.

The treatment and disposal of wastewater presents problems for communities of all sizes, but particularly for smaller communities (population up to a few thousand) with their limited financial resources. The typical small town does not have easy access to a large river, but must rely on some nearby creek or stream for disposal of wastewater. The problem becomes even more difficult when the size or assimilative capacity of the available stream is insufficient to accommodate the quantity of wastewater being produced. It then becomes necessary to either provide a suitable level of treatment to meet the applicable standards or find some alternate means of disposal. Ponds are one possible solution to this problem.

The use of ponds for waste stabilization has been practiced in Europe and Asia for centuries, but it has only been within about the last fifty years that ponds designed specifically for waste treatment have been constructed. According to Barsom,[1] in 1945 there were less than fifty municipalities in the United States that used any form of waste stabilization pond, known also as oxidation ponds, lagoons, or other synonym. By 1971 this number had risen to about 4500. Additional installations in use by business, industry, and various institutions no doubt number into the thousands.

The advantages of waste stabilization ponds lie in their simplicity of design, construction, operation, and their relatively low cost. In spite of their apparent simplicity, ponds can produce a high degree of stabilization. Actually, the processes that occur in ponds are quite

complex, and it is only through continuing scientific and engineering research that we have reached our present understanding of the fundamental biochemical reactions and biological relationships that take place in waste stabilization ponds.

In recent years there has been an increasing emphasis on wastewater treatment, and at present The Environmental Protection Agency regulations establish a maximum BOD_5 of 30 mg/l and a maximum suspended solids of 30 mg/l for all municipal effluents. Under ordinary conditions, the effluent of many ponds fails to meet these limits, particularly with respect to suspended solids. In typical pond effluent the solids are mostly algae which are generated by the normal functioning of the pond.

Although many waste stabilization ponds are in use, few serious pollution problems have been caused by their effluents. This may be due to the fact that ponds are typically small in size and discharge relatively small quantities of water. However, it is also to be noted that the nature of the discharged solids is different from that resulting from other methods of wastewater treatment. But this difference has apparently been largely overlooked, and pond effluent is not considered different from any other secondary treatment effluent.

The elimination of waste stabilization ponds as wastewater treatment systems would be extremely costly, and would create many additional problems. The small municipality that depends on a pond for its wastewater treatment cannot afford a sophisticated mechanical treatment plant. Construction costs per capita would be completely unreasonable, and could not be tolerated. But even if the plant were given to the municipality, operation and maintenance costs would increase dramatically over those for a pond system. An additional problem would be that of recruiting and retaining certified personnel to operate the facility. In consideration of these serious consequences of replacing ponds with other types of facilities, it is prudent to first determine if the operation of ponds can be improved so that their effluent can consistently meet the requirements for effluent quality.

The present work was undertaken to explore the various aspects of the use of porous media filters for the removal of suspended solids from waste stabilization pond effluent in order to improve beyond reproach the quality of the effluent. At the time this work was begun, the limit on

suspended solids content of municipal effluent had been established at 30 mg/l. Since that time, however, the rules and regulations have been changed so that many smaller ponds are no longer required to meet this limit. Exerpts from the Federal Register governing this change are reproduced as Appendix A of this report.

The fact that there are now exceptions to the general rule does not lessen the need for economically feasible methods for reductions of suspended solids in effluents. Present philosophy in the area of wastewater treatment is to produce the best results possible, and it is believed that the trend toward more stringent requirements with few, if any, exceptions is not likely to be soon reversed.

II. General Features of Waste Stabilization Ponds

Nearly 20 years ago the need for standardized terminology relating to waste treatment ponds was noted by D. F. Smallhorst.[2] It is indeed unfortunate that this need still exists. Among the terms used to describe man-made depressions in the ground used for the treatment of wastewater are the following: lagoon, stabilization lagoon, waste treatment lagoon, waste stabilization lagoon, sewage lagoon, oxidation pond, waste pond, stabilization pond, and waste stabilization pond. Descriptive prefixes such as aerobic, anaerobic, facultative, aerated, sludge, and manure are also used.

Schemes for classification of ponds have been proposed, most notably that of the American Society of Civil Engineers,[3] but none have proven very satisfactory. Seasonal environmental factors fluctuate, and the fundamental mode of operation of a pond may change markedly. Based upon use, operation, design, and chemical, biological, and physical characteristics, ponds have been classified according to depth, main source of oxygen, rate of organic loading per day; hydraulic arrangements including inlet, flow-through pattern, outlet and recirculation design; and method of effluent disposal by release to a stream, percolation, evaporation, or transpiration from cover crops.

Although ponds generally appear to be calm bodies of water, the continuously occurring reactions and interactions are quite complex. Figure 1 illustrates the major interrelationships that are involved.[4] The process begins with the supply of organic matter that is a component of the influent sewage. The organic matter is metabolized by bacteria with concomitant increase in the bacterial biomass. Carbon dioxide is also released and is used by algae in the presence of sunlight to form additional algae and to release oxygen. In simplified form, the following equations illustrate the reactions:

Aerobic conditions:

$$\underset{\text{(organics)}}{2\ CH_2O} + O_2 \xrightarrow{\text{bacteria}} \underset{\text{(bacteria)}}{CH_2O} + CO_2 + H_2O$$

Anaerobic conditions:

$$2\ CH_2O \xrightarrow{\text{bacteria}} CH_3COOH \xrightarrow{\text{bacteria}} CO_2 + CH_4$$

Algae utilization:

$$CO_2 + 2\ H_2O + \text{energy} \xrightarrow[\text{(algae)}]{\text{algae}} CH_2O + O_2 + H_2O$$

Both the algae and bacterial masses are consumed by microscopic herbivores who, in turn, are consumed by carnivores which are somewhat larger

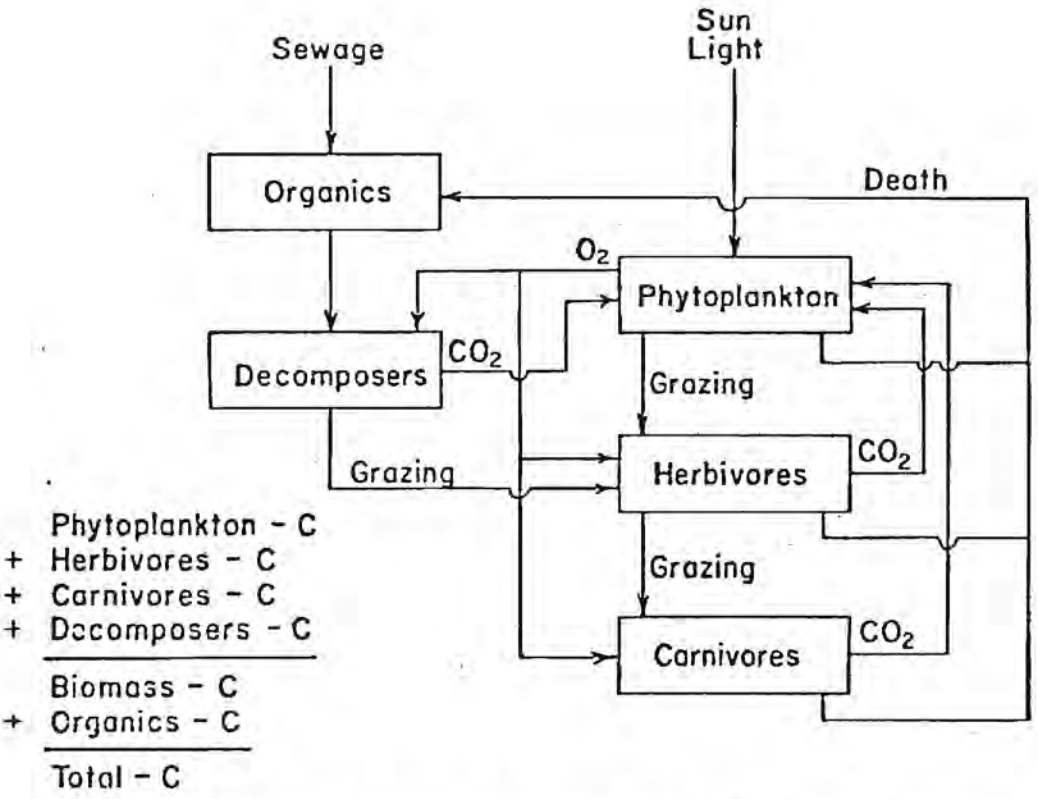


Figure 1. Food Chain in a Waste Stabilization Pond

animals. Death of any of the living components returns the organic material to be recycled through the chain again.

All of these various types of organisms play a role in the stabilization of degradable organic matter, and they are all related through the food chain. Hence, the organic content of a pond consists of the unassimilated components of the influent sewage plus the content of all the organisms present in the pond. Effluent, therefore, includes dissolved

organics, bacteria, and other organisms which will pass through filter paper and a suspended fraction which can be caught on filter paper.

The type of pond most characteristic of the coastal plains area is a large, relatively shallow depression used to treat wastewater that contains settling solids. The solids accumulate on the bottom and decompose anaerobically. Depending on the pond loading and other factors, the dissolved and non-settling particulate matter may decompose either aerobically or anaerobically. These ponds are frequently termed "facultative."

In general, the sludge layer or benthos remains continuously anaerobic and the surface, in content with the air, has at least a small amount of dissolved oxygen and typically a substantial content of dissolved oxygen. The central layer of the pond contains facultative bacteria and varies in oxygen content between day and night as well as according to depth. The build-up of settleable solids is a function of temperature, and in all situations the degradable solids strongly influence the reactions that occur in the pond. In multi-cell designs, sludge build-up

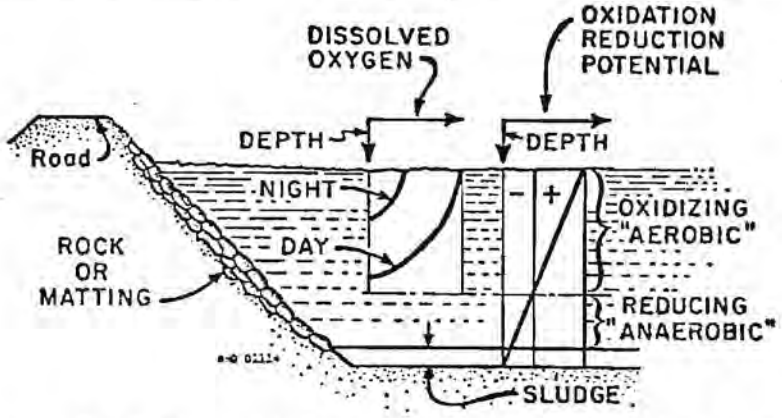


Figure 2. A Facultative Waste Stabilization Pond

beyond the first cell is negligible. There is also very little build-up in polishing ponds that follow facultative ponds.

In facultative ponds, oxygen is supplied through two mechanisms. The main source is due to photosynthesis by the algae under the influence of sunlight, and the other source is direct transfer from the atmosphere. When wind action is appreciable, particularly in larger ponds, surface aeration becomes quite significant. Figure 2 indicates the dissolved oxygen and oxidation-reduction potential patterns of a typical facultative pond. The dissolved oxygen content is higher during the day when

sunlight allows photosynthesis to occur; it is diminished during the night. The measurement of oxidation-reduction potential shows the tendency toward true aerobic or anaerobic conditions. The reducing environment will be found near the bottom, indicating true anaerobic conditions.[5]

Some specific values reported by Rich[4] for a pond in South Carolina are given in Fig. 3. As used in this figure the term "oxypause" is the depth where oxygen depletion occurs. The diurnal variation of pH and

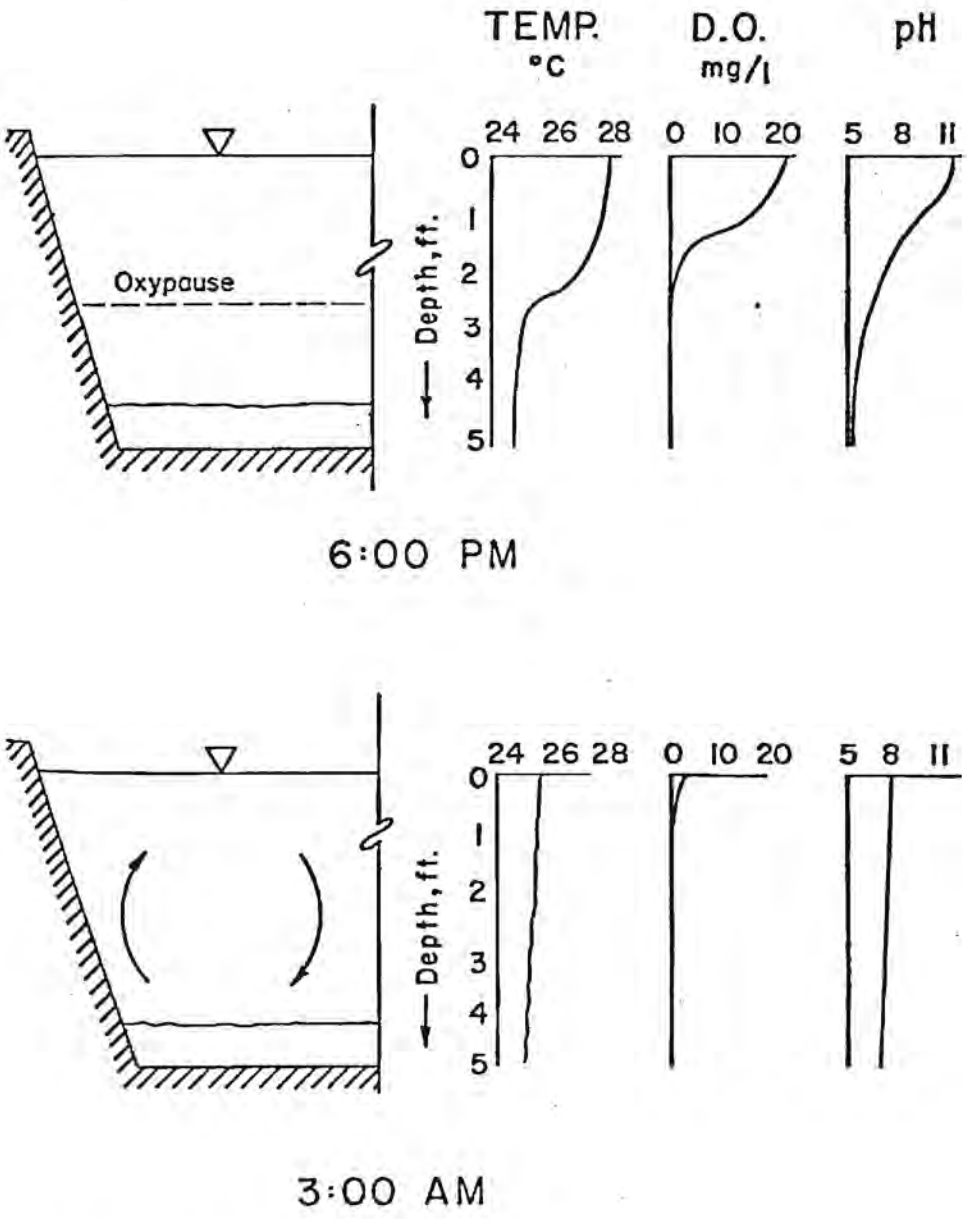


Figure 3. Profiles Typical of Summer Conditions

dissolved oxygen at the pond surface during the summer are shown in Fig. 4. Carbon dioxide is removed in the upper layers of the liquid by photosynthesis, and this is the cause of the high pH values which are observed.

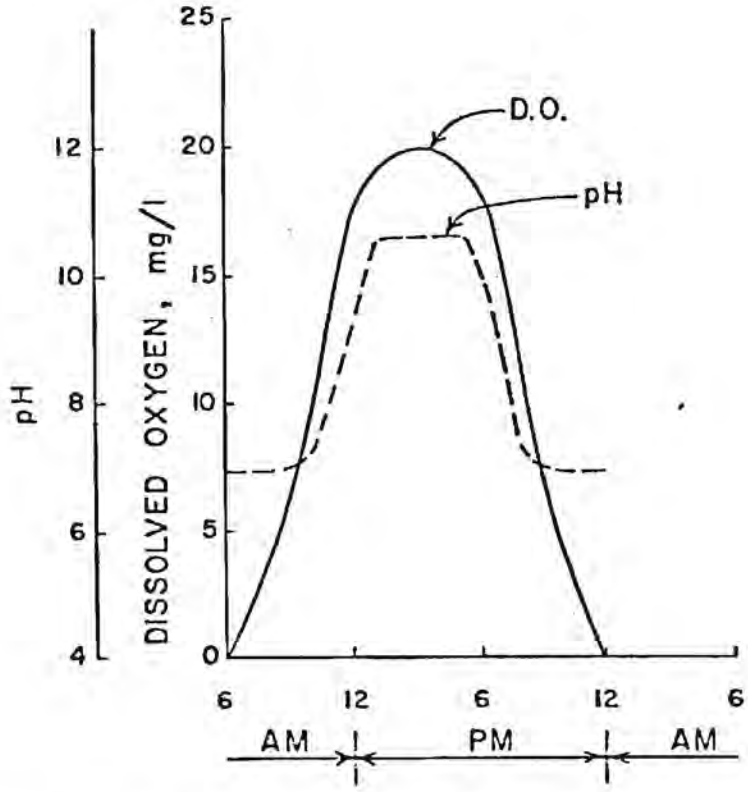


Figure 4. Diurnal Variation in pH and D.O. at the Surface During the Summer

Because of sunlight absorption by algal cells and other particulate matter, effective light penetration may be less than one meter, and oxygen production is therefore confined to the upper layer. In the absence of mixing, gradients of dissolved oxygen develop, descending from a maximum at the surface to zero or near zero in the deeper layers. This condition is accompanied by temperature gradients which effectively inhibit mixing by wind action. Thermal stratification may also be promoted by a temperature differential between the pond and the influent. Three different situations can be readily identified that may cause the influent to 1) rise to the surface, 2) settle to the bottom, or 3) form an intermediate stratum. These possibilities are illustrated in Fig. 5.

Wind is usually the principal source of energy for mixing the water in facultative ponds, but a secondary cause of mixing that may be of

significance in tropical areas where the wind velocity is low is differential heating. Mixing is an important factor in the growth of algae, for many algae are non-motile and mixing is necessary to bring them into the zone of effective light penetration. If mixing is reduced during the usual diurnal cycle, a reduction in the generation of certain algae may follow, resulting in a shift from one dominant species of algae to another. Also, mixing during daylight aids in the distribution of dissolved oxygen.

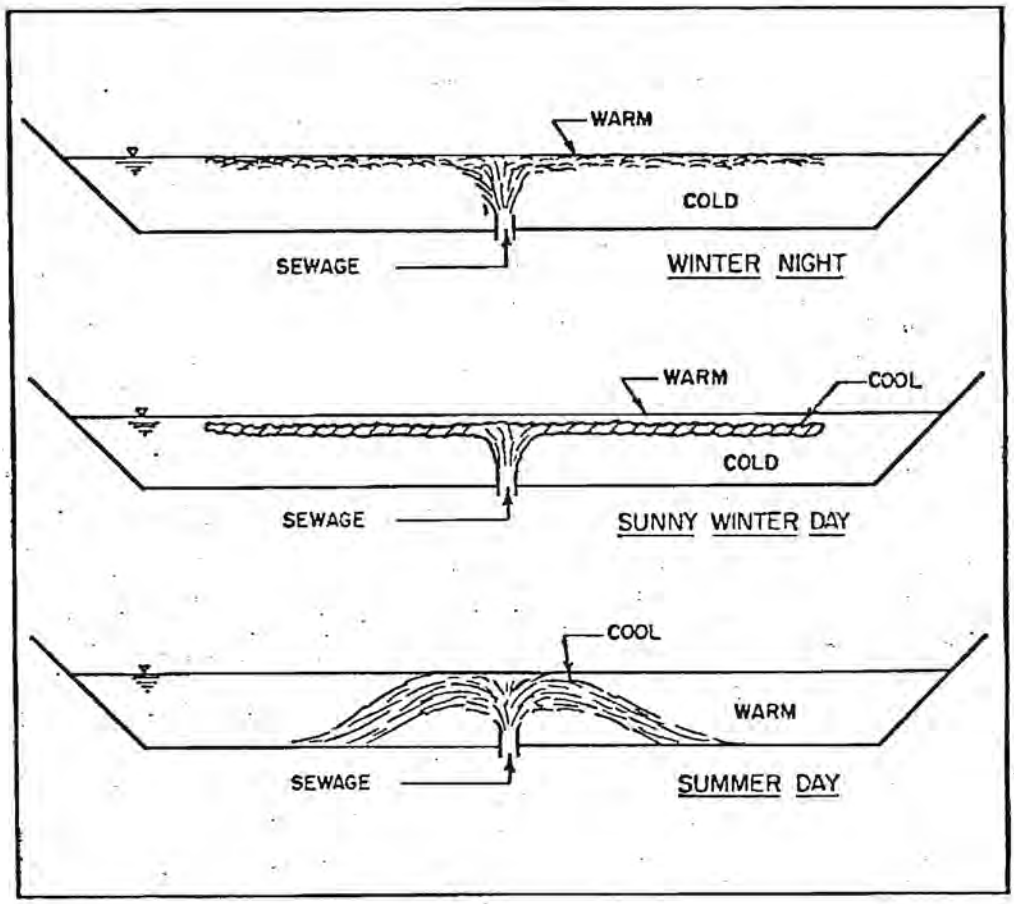


Figure 5. Stratification Due to Thermal Differences Between Influent and Pond Water

Another factor of great importance is temperature because it affects the rate of chemical and biochemical reactions. The average temperature, daily fluctuations, and yearly variations all influence the biological, chemical, and physical processes in the pond.

Facultative ponds are typically 3 to 5 feet in liquid depth and receive organic loadings in the range of 10 to 100 pounds of BOD_5 per acre

per day. Influent may be raw or settled sewage. Detention time varies with the situation and the climate, but probably averages around 40 days. Conventional facultative ponds do not include mechanical aeration equipment in either single or multi-cell designs.

Kinetic Model of Pond Breakdown Action

If it is assumed that all the influent BOD is stabilized by facultative organisms, that complete mixing occurs, and that breakdown takes place according to a first-order reaction, the effluent and influent BOD concentrations may be described by Equation 1. Although it provides a useful basis, this is an idealized equation that does not take into account the difference between the biological breakdown rates of the soluble material and those of the settleable solids.

$$L_p = \frac{L_o}{K_T R_T + 1} \qquad (1)$$

where

L_p = pond and effluent BOD_5 (mg/litre)
L_o = influent BOD_5 (mg/litre)
K_T = breakdown rate at temperature T
R_T = detention time at temperature T

The breakdown rate, K_T, depends on the temperature as follows:

$$\frac{K_{35}}{K_T} = \theta^{(35-T)} \qquad (2)$$

where

T = pond operating temperature (^oC)
θ = temperature reaction coefficient = 1.085
and K_{35} = breakdown rate at 35^oC

For a fixed percentage reduction of BOD, the symmetry of K_T and R_T in Eq.1

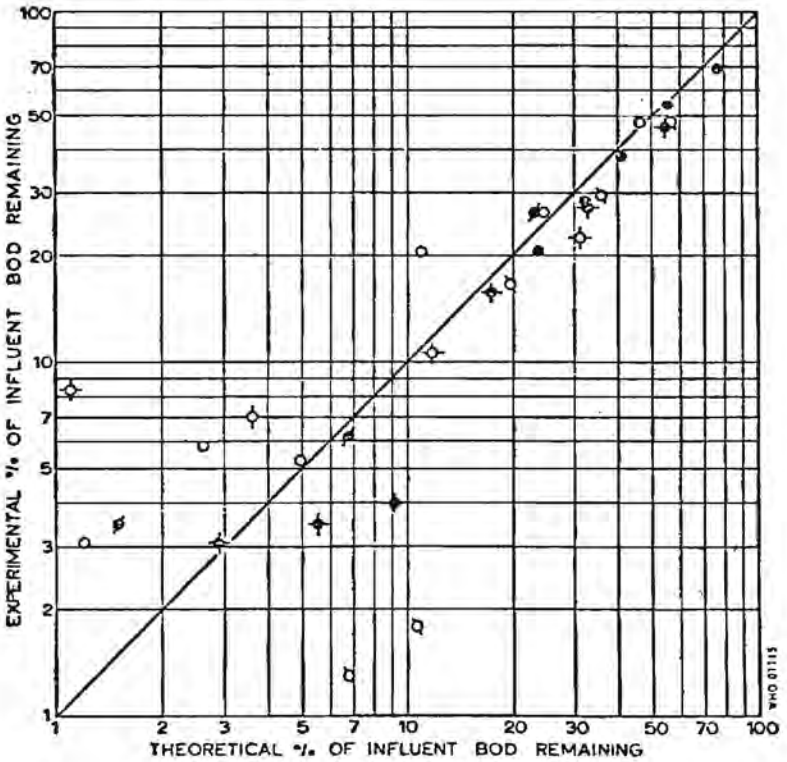
permits Eq.2 to be expanded as follows:

$$\frac{K_{35}}{K_T} = \theta^{(35-T)} = \frac{R_T}{R_{35}} \qquad (3)$$

where

R_{35} = detention time at 35°C

Data obtained by Suwannakarn and Gloyna[6] from a series of laboratory-scale ponds treating a synthetic non-settling waste at a number of different temperatures were analysed by Marais,[7] who obtained values for



From Marais (1966), based on experimental data obtained by Suwannakarn & Gloyna (1964).

Figure 6. BOD Removal in Laboratory-Scale Series of Oxidation Ponds: Correlation of Experimental and Theoretical Results

K_{35} and of 1.2 and 1.085 respectively. Extensive laboratory and field studies[8] have shown that certain beneficial green algae cease to function effectively at water temperatures in excess of 35°C. Using Eq. 1 and a measured value for K_{35}, therefore, the detention time for any percentage reduction at 35°C can be determined. At any other temperature (T), the detention time (R_T) for the same percentage reduction can be determined by using Eq. 3.

The correlation between Suwannakarn and Gloyna's experimental BOD_5 data and theoretical values is shown in Fig. 6. These data verify the mathematical model under idealized conditions of waste composition, temperature, and mixing.

The projected efficiency of a facultative pond might be established by tabulating various values of K_T, R_T and T. Table I provides values of K_T for different temperatures, assuming the reaction rates remain constant.

TABLE I

VALUES OF K_T*

Temperature (°C)	5	10	15	20	25	30	35
K_T per day	0.103	0.12	0.24	0.35	0.53	0.80	1.2

* After I. Duarte (personal communication, 1968).

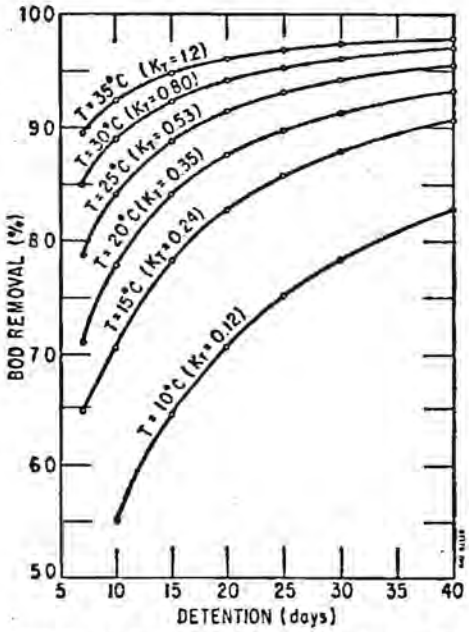
On the basis of Eq. 1, the BOD removal efficiencies can be calculated for various values of R_T and K_T:

$$\text{Removal}\,(\%) = \left(\frac{L_o - L_p}{L_o}\right) 100 = \left(1 - \frac{1}{K_T R_T + 1}\right) 100 = \left(\frac{R_T}{\frac{1}{K_T} + R_T}\right) 100 \qquad (4)$$

In Fig. 7, idealized removal efficiencies are plotted against various detention periods. While this graph does not provide all the information required to design a pond, it does demonstrate the important relationship between temperature and detention time.

It is evident, however, that the equations suggested above may fail to describe the effects produced by settleable solids. For example, they do not take into account the influence of soluble BOD released from the sludge layers and the toxicity effects exhibited by certain industrial wastes.[9,10]

Aerated facultative ponds have been described by several authors,[11,12,13] but they vary fundamentally through provision for the mechanical introduction of oxygen in order to relieve organic overload, reduce time of treatment, or to reduce odor problems. Organic loadings are generally in the range of 10-300 pounds pounds BOD/acre/day and detention times may be any period from 1 to 2 days to a month. BOD removal of 95% is possible, depending on detention time and solids removal.



Data from I. Duarte (personal communication, 1968).

Figure 7. Idealized BOD_5 Removal Rates in Facultative Ponds

In complete-mix aerobic ponds solids remain suspended and are stabilized aerobically. This type of pond is typically 8 to 10 feet deep and is loaded at a rate in excess of 100 pounds BOD/acre/day. Photosynthetic oxygenation is reduced due to solids that are kept in suspension, and a mechanical aeration system is used to provide dissolved oxygen. Facilities of this type have been discussed by McKinney,[14] Sawyer,[15] and Burkhead and McKinney.[16]

High-rate aerobic ponds are generally 12 to 18 inches deep to allow maximum light penetration in order to maximize the production of algae. Mechanical mixing is used and detention time is in the range of 2 to 6 days, and loadings are 100 to 200 pounds BOD/acre/day. Conversion of organic matter to algae is usually 80 - 95%. Additional details have been

given by Oswald and Gotaas[17] and by Oswald.[18]

Anaerobic ponds are typically deep, heavily loaded facilities that are about the same as an open, unheated, unstirred digestor. They are generally designed with small surface areas and a depth of 8 to 10 feet. There is a relatively solids-free liquid layer above a layer of settled solids. A floating scum layer may occur depending on the nature of the waste.

Tertiary ponds, also termed maturation ponds, are generally used for polishing effluents from conventional secondary treatment processes, such as trickling filtration or activated sludge. Detention times of from one day to several weeks reduce BOD, suspended solids, coliform count, nitrogen, and phosphorous in the effluent. Depth is 1 to 5 feet; oxygen is supplied photosynthetically, sometimes supplemented by mechanical aeration. BOD loadings are normally less than 15 pounds/acre/day, but may be much higher. Loeler and Stephenson[19] and Weiss[20] have described tertiary facilities of several types.

A summary of the characteristics of major types of ponds are given in Table II. All of the values listed are approximate, and exceptions can be readily found.

Table II. Types of Waste Stabilization Ponds

Type	Depth, feet	Loading, lb BOD_5/acre/day	BOD removal or conversion, percent
High-rate aerobic pond	1 to 1.5	60 to 200	80 to 95
Facultative pond	3 to 8	15 to 80	70 to 95
Anaerobic pond	Variable	200 to 1,000	50 to 80
Maturation pond	3 to 8	<15	Variable
Aerated lagoon	Variable	Up to 400 lb/acre/day	70 to 95

III. Methods for Upgrading Pond Operations

With increasingly stringent effluent requirements, modifications of existing facilities may be required to meet all treatment objectives. In the coastal plains area, suspended solids content of effluent is frequently above levels presently mandated. The BOD associated with the solids is also high, but generally decreases proportionately with the solids content.

Figure 8 depicts average effluent characteristics for three types of ponds. None of these meets the limitations of 30 mg/l, and clearly the

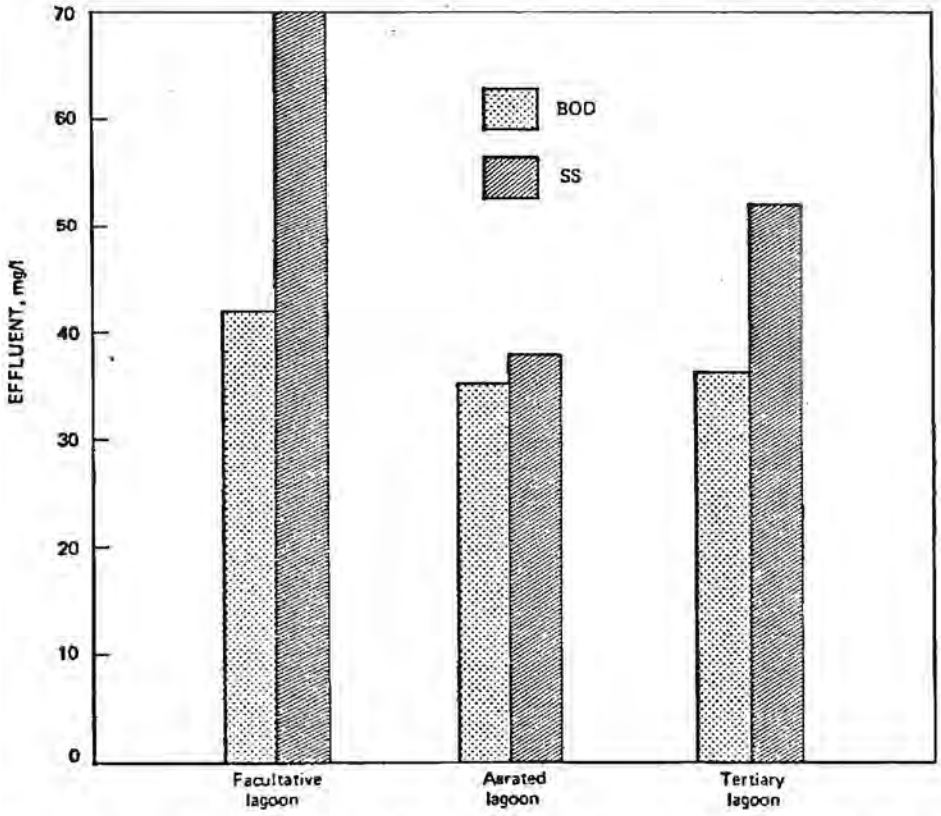


Figure 8. Performance of Waste Stabilization Pond Systems

facultative design, although most prevalent among ponds, is very poor in this respect. The suspended solids in the effluent of facultative ponds consist mainly of algae. Although certainly not as objectionable as the solids present in influent sewage, they do exert an oxygen demand and are definitely organic matter.

The need to produce increasingly higher quality effleunt has resulted in many investigations. Some methods tried have produced excellent

results but at intolerably high costs. Other procedures have resulted in improvements, but the optimum has by no means been yet achieved.

Much can be done to produce high efficiency ponds through appropriate design of the process and the physical facility, including flow patterns and other hydraulic considerations.

Two factors that are well-established as determinants of pond performance are detention time and loading. Figure 10 shows the relationships for canning wastes, and municipal wastes would follow the same general pattern. From this figure it is readily seen that improvement would result from increased detention time, reduced loading, or the addition of other ponds to the system. Increasing depth adds detention time but should be approached with caution, as the mode of operation might be altered. Decreased loading might be accomplished by pretreatment, possibly by sedimentation. Increased system capacity would be provided by employing existing ponds, or by adding new ones, either in series or in parallel with extant ponds.

Flow patterns are of major importance and may be controlled by placement of inlet and outlet structures, baffles, and by configuration of the

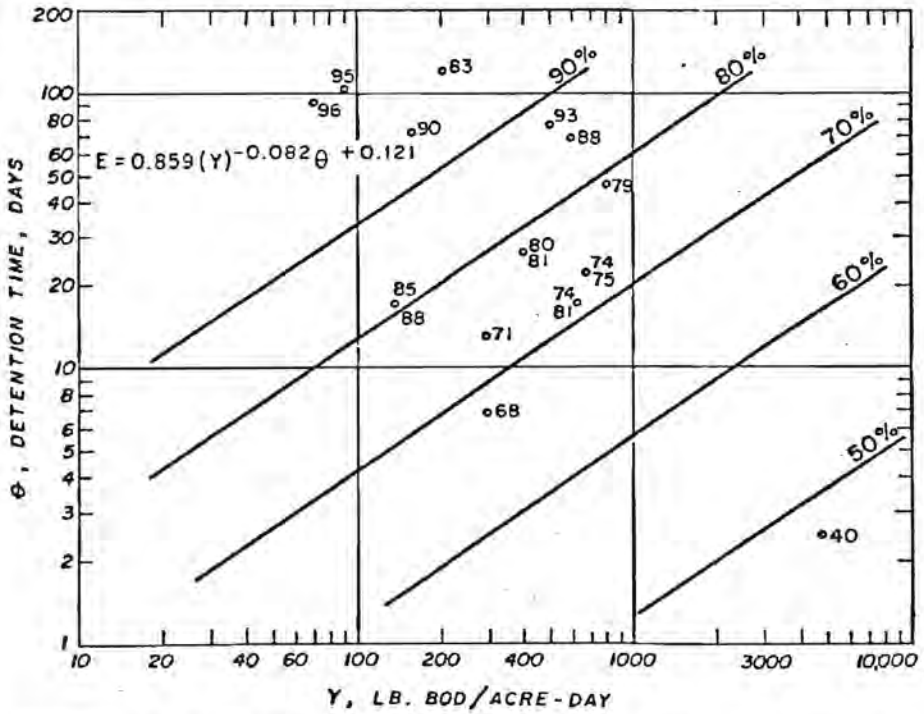


Figure 9. BOD-Removal Relationship for Ponds Treating Cannery Wastes

pond. Pumping facilities may be required to provide recirculation in series, parallel, or series-parallel flow situations. The return of flow often provides algal cells in the feed area where they provide photosynthetic oxygen where oxygen is most needed to prevent odors or the development of anaerobiosis. Recirculation may also provide some mixing, which is considered desirable, but mechanical systems are much more efficient with respect to the mixing process.

Recirculation in a series arrangement decreases the effective organic loading in the first cell by flushing influent through faster than would occur without recirculation. The hydraulic retention time of the influent and recycled liquid in the first pond in a series system is

$$T = \frac{V}{(1+r)F}$$

where v is the volume of the pond cell, F is the influent flow rate, r or R/F is the recycle ratio, and R is the recycle flow rate.

The series arrangement reduces the BOD of the mixture entering the pond and may be calculated:

$$S_m = \frac{S_{in}}{1+r} + \left(\frac{r}{1+r}\right) S_3$$

where S_m is the BOD of the mixture, S_3 is the BOD of the effluent from the third cell, and S_{in} is the BOD of the influent. This shows that the organic load is spread more evenly throughout the system, and potential odor problems near the feed point are less probable.

Parallel arrangements reduce loadings by spreading them across all ponds instead of having all the flow enter the first cell of a series design. The design of inlet and outlet structures and their placement is another factor of importance in pond design. Ponds receiving raw sewage almost always are fed by a single pipe, but with primary or secondary effluent this tends to overload the feed zone. Multiple entry and/or multiple exit arrangements also find use. It has been reported[21] that multiple exits reduce the occurrence of blue-green algae mats and their potential for creating odors.

It is sometimes possible to overcome problems, particularly those of a seasonal nature by supplemental aeration and/or mixing. Mechanical

aerators are generally used where oxygen requirements are high, but compressed air aeration has the advantage in cold climates of preventing surface freezing.

Aeration also breaks up thermal stratification and mixing tends to increase algae and to maintain aerobic conditions deeper in the pond. Increased algal population increases oxygen generation capacity, and therefore increases the capacity for organic loading. Surface agitation is advantageous, as it breaks up any scum layer that may form on calm days and thereby reduce the rate of photosynthesis and also the rate of oxygen transfer from the air.

IV. Removal of Algae

A different approach to the improvement of pond performance is to remove the suspended solids from the effluent. As the solids are mainly algae, their removal also reduces the BOD. However, the separation of algae from water is quite difficult due to their small size and their density, which is not very different from that of water. Also, they do not tend to agglomerate into conveniently removable masses due to their mutually repulsive charged state (negative). This combination of properties has led to many different approaches to the desired liquid-solids separation. Filtration, flotation, centrifugation, and various chemical coagulants have been tried along with such techniques as land application. Following is a discussion and review of some of those procedures and strategies, preceded by a brief discussion of algae that may be involved.

There are four classes of algae: green algae, blue-green algae, diatoms, and pigmented flagellates. A few types of algae, characteristically found in polluted water are illustrated in Fig. 10. Due to their differing characteristics, different removal efficiencies may be produced according to the classes that are present. Chlorella and Scenedesmus are probably the most frequently occurring algae in waste stabilization ponds, although Ankistrodesmus, Microactinium, Actinastrum, and Closterium are very common. All of these non-motile algae except Chlorella have sharp projections that maximize surface area per mass and they are able to survive in the presence of predators. Motile algae proliferate particularly well due to their ability to move to their optimum level of light. Major species include Chlorogonium, Phacus, Pandorina, and Carteria. The pigmented flagellates Chlamydomonas and Euglena are common. The cell wall of Euglena is flexible which allows it to pass through constrictions. Motile algae are particularly difficult to remove by sedimentation or flotation processes, as they are able to swim away.

Blue-green algae are responsible for many of the foul odors that can be produced by ponds. Oscillatoria, Anabaena, and Phormidium, are filamentous organisms that tend to form mats which cause the obnoxious odor usually described as "pig-pen." It has been noted that filamentous algae

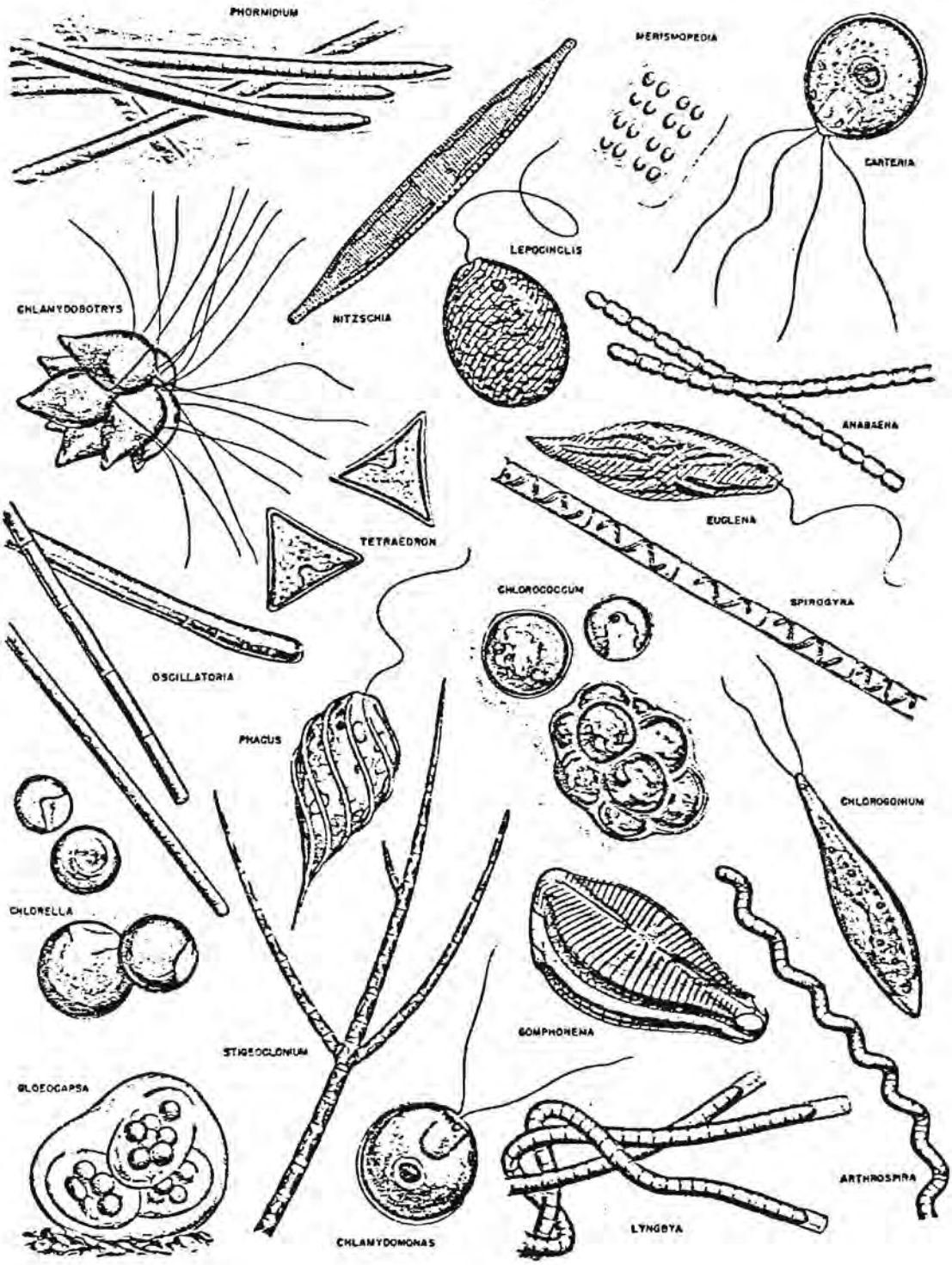


Figure 10. Algae Found in Polluted Water

survive because animal predators remove the flagellated algae, leaving those undesirable forms to proliferate.

Diatoms have a silica shell, are non-motile, and may be found in waste stabilization ponds. The most common diatom is Navicula. As previously noted, algal cells carry a negative charge and the mutual repulsion tends to keep them separated. The repulsion can be overcome by the addition of chemical reagents which alter the charge pattern and allow agglomeration into flocs which can then be removed. Some previous investigators[22-25] have tried the use of various organic polymers, but the general opinion is that this is not economically feasible. The action of some polymers is quite sensitive to pH, and the variation in pH typical of photosynthetically active ponds may be one cause of erratic results.

Inorganic reagents, most frequently alum, have produced better results than polymers alone. Iron compounds may also be useful coagulants, but their use has been limited due to the color they impact to the effluent. Lime alone or in combination with other reagents has been used. The choice of coagulant and the possible use of an organic coagulant aid depends on a number of factors, including results sought, quality of the effluent, type and concentration of algae, the total process concept, and of course, the cost.[26-29] There appears to be no substitute for actual trial when a choice is to be made. For tests, laboratory and pilot scale studies, and larger demonstrations are viable approaches, but it has been found that results obtained under laboratory-control conditions do not necessarily correlate well with results obtained in the field. This may be due to environmental influences or to problems of scale.

Sedimentation alone is ineffective for algae removal, although it can be utilized following coagulation and floculation processes. In such a sequence a chemical coagulant is added to destabilize the algae. Then a floculation period is provided during which the particulates are agglomerated into flocs which are large enough to settle at a reasonable rate. This procedure is capable of high algae removal as reported by several investigators.[22,27] Some performance data are given in Table III. Sedimentation overflow rates have been in the general range of 0.2 to 0.8 gpm/ft^2 with a hydraulic retention time in the order of 3-4 hours. The concentration of settled solids has been low, averaging about 1% when alum or iron is used. The use of tube settlers appears useful in reducing the

Table III. Summary of coagulation-flocculation-sedimentation performance

Investigator and location	Coagulant	Dose, mg/l	Overflow rate, gal/min/ft²	Detention time, min	BOD			SS		
					Influent, mg/l	Effluent, mg/l	Percent removed	Influent, mg/l	Effluent, mg/l	Percent removed
van Vuuren et al.,[27] Windhoek, South Africa	Alum[a]	216-300	0.27	200	27.3	9.5	95	85	17	80
	Lime[b]	300-[c]400	.27	200	27.3	3.5	87	85	8	92
Golueke et al.,[22] Richmond, Calif.	Alum	100	.78	150	23.0	1.0	96	199	13	93
Goodwin,[48] Napa, Calif.	Lime	[d]200	[e]	[e]	30.0	3.6	88	102	23	79
	Alum	45								

[a]As $Al_2(SO_4)_3 \cdot 14.3\ H_2O$ (molecular weight = 600).
[b]As CaO.
[c]pH 10.7.
[d]pH 10.8.
[e]Not available.

size of sedimentation basins. One study[30] has indicated that overflow rates as high as 5 gpm/ft^2 may be practical.

Algae can be separated from water by flotation processes in which fine air bubbles are physically attached to the particles, causing them to rise to the surface. The addition of a chemical coagulant promotes larger particles which can be removed with somewhat higher efficiency.

There are two different means of providing the fine bubbles needed for the flotation process: autoflotation and dissolved-air flotation. Autoflotation uses a zone of turbulence around the inlet to the flotation tank which leads to the escape in the form of bubbles of dissolved gases in the influent liquid and from oxygen supersaturation in the pond. It is reported[31-34] that the dissolved oxygen content of the pond must be in the 13-15 mg/l range or above for the process to work satsifactorily. The use of carbon dioxide instead of acid for the adjustment of pH is also desirable, as it increases the partial pressure of CO_2 and enhances the production of bubbles. The main difficulty with autoflotation is the need for oxygen supersaturation, a condition that is difficult to maintain continuously under normal loading conditions.

Dissolved-air flotation is the other method for producing fine bubbles. In this process some of the influent is pumped into a pressure tank and agitated with high-pressure air. When the liquid is mixed with influent and the pressure is released, bubbles are formed. This process does not depend on photosynthesis for oxygen production and can continue as long as the pump operates. This reliance only on the power supply is a great

advantage, and normally dictates this procedure rather than autoflotation.[35]

Flotation processes require smaller tanks than sedimentation, but there are many factors that influence the efficiency of flotation, and operational control of the process may be difficult. Sedimentation is a simpler process, as no bubble-producing pumps or compressors are needed, and operation and maintenance are much easier.

Among the factors of importance in dissolved-air flotation are surface-loading rates, air/solids ratio, pressure, coagulant, coagulant dose, point of addition, pH, and design of the tank. Overflow rates are in the order of 2.0-2.7 gpm/ft^2 compared to sedimentation overflow rates of 0.2 to 0.8 gpm/ft^2 as mentioned above.

Another aspect of processes that produce concentrated solids is the handling and disposal of the solids. Float concentrations have been reported[31] in the range of 0.13-3.6% depending on the situation and manner of operation, although most values fall in the 1-2% span. So far, the most widely used coagulant has been alum, and alum-algae sludges have received most attention.

Alum sludges have long been recognized as difficult to dewater, and the presence of algae in the sludge does nothing to improve the situation. Traditional dewatering methods of centrifugation and vacuum filtration have produced marginal results at best, although heat treatment gives some improvement.[32] Zimpro low and high oxidation processes have been tried and are clearly superior to other methods, but still leave much to be desired. Oxidation of sludge with chlorine (Purifax process) has been shown to produce a material that can be dewatered on a sand bed, but chlorine is expensive, and the environmental impact of heavily chlorinated matter may be adverse.[32] Anaerobic digestion of algae was reported by Golueke et al.[36] as unsatisfactory, although better results may be possible if the algae are dead prior to entering the digestor.

To date, the best sludge handling/disposal procedure has been to return the sludge to the waste stabilization pond. The only precaution seems to be the provision of arrangements that spread the sludge rather than allowing excess build-up around the entry point. It is estimated that accumulation on the bottom of the average pond would be no more than 1-2 inches per year.[37] It is also recognized that coagulant recovery might be

economically attractive, but little work has been done in this area so far.

Centrifugation has been found to work satisfactorily in the separation of algae from water. It is, however, a very expensive procedure not only in terms of capital investment, but particularly power costs which may significantly exceed $100 per million gallons.[35,38]

Land treatment of pond effluent is a technique that offers opportunities for development. Where the terrain is suitable, effluent is distributed along the top edge of a wide, gently sloping grassed area. Some water is lost through percolation, a circumstance that may or may not be desirable. Over a properly dimensioned area, dosed intermittently, satisfactory results are obtained.[39]

All the above methods of suspended solids reduction are based on the removal of algae from pond effluent. A different approach to the problem is to remove algae from within the pond, or to prevent them from appearing in the effluent. The Oklahoma State Department of Health has, for instance, been investigating aquaculture as an algae removal process.[40] Their approach has been to raise fish in a series pond arrangement of six cells. The fish are subsequently available for various beneficial purposes although not for human consumption.

Fish culture has a certain appeal as a means of (1) removing algae from ponds and (2) obtaining a beneficial by-product. While there is at present no great amount of information available on this subject, some studies have been carried out in the United States and elsewhere. It appears somewhat difficult to optimize the dual objectives of algae removal and food production, although the techniques are not inconsistent. The nutrients present move through a food chain of bacteria, plankton, and other small aquatic organisms to reach the level of fish, and there are several inherent problems. It is necessary to maintain a sufficiently high level of dissolved oxygen and avoid sludge deposits and deleterious surface growths. Toxic substances must be absent, and a biological balance that will yield adequate quantities of fish food must be maintained.

Substantial quantities of fish can be raised per acre of pond, but there are difficult questions concerning the sanitary aspects if the fish are to be used for human consumption. In Europe it is considered satisfactory if the fish are removed to clean water 2 or 3 weeks prior to consumption. It is interesting to note, however, that in Southwest Asia, farmers

raising fish on sewage sell them and buy others for their own consumption. The use of fish in animal food and for other purposes is less troublesome. The prospect of a salable product is likely to stimulate increased investigation in this area.

Series pond arrangements promote lower algae concentration in their effluents, due to possible increased sedimentation, but this is strongly influenced by the hydraulic settling characteristics of the algae species present and by wind mixing. A more likely view of the situation is that each pond beyond the first is operating in "normal" fashion, but with successively lower loadings. It is also possible to use intermediate chlorination between cells of a series arrangement. The chlorine kills algae and promotes settling, but releases a substantial amount of soluble BOD into the water.[41,42]

Intermittent discharge lagoons are generally loaded at low rates and have sufficient capacity to require discharge only twice a year. Times for discharge are chosen to coincide with periods of low algae content. This technique is of more limited value in warm climates where there may be insufficient periods of low concentration of algae. The addition of a chemical coagulant prior to discharge may be of value in some cases, and was a very successful procedure when tested in Ontario.[43]

Filtration processes are commonly used to good advantage for liquid/-solids separation, and considerable effort has been devoted to algae removal by such a technique. In general, however, the small size of algae, their surface change, and their low density result in rather poor removals at concentrations typical of waste stabilization pond effluents. In situations of low algae concentration much better results are obtained. If the filtration step is preceded by preliminary processes such as coagulation or sedimentation which reduce the suspended solids level, filtration can produce effluent of almost any quality that might be desired.

Intermittent sand filtration is a technique that has been under study.[44,45] Good results have been obtained, although only influents of low to moderate suspended solids content were investigated. One drawback to this technique is the need for periodic cleaning of the sand which requires considerable labor.

Microstraining has been attempted in a number of locations with uniformly poor results, as is shown by the comments summarized in Table IV.

Table IV. Summary of Microstrainer performance

Investigator and location	Finding
Golueke et al.[22] ..... Richmond, Calif.	"At the most, only an extremely small amount of algae was removed by the machine even with the addition of filter aid, decrease in flow rate, and the slowing of the rotational speed of the filter."
Dryden et al.,[46] ..... Lancaster, Calif.	A 23-μm microstrainer was tested. "Removals with the microstrainer were totally inadequate and blinding by the bodies of crustacea and other foreign material occurred quite rapidly."
Lynam et al.,[47] ..... Chicago, Ill.	56-percent BOD removal, 61-percent SS removal. Less than 43 percent of the algae were removed.
California Department ... of Water Resources,[48] Firebaugh, Calif.	25- and 35-μm screens were tested. "Operation of the unit soon showed that algae were passing through the finer screen. Removals up to 30 percent were obtained, but most of this was due to algae settling in the influent and effluent chambers."

Microstrainers reportedly work well in removing algae from water supply sources, but clearly the size of the individual particles is larger than those found in ponds.

Although sufficient data does not exist to fully evaluate the various techniques and processes for removal of algae, it is possible to estimate some relative values. Table V shows what might be expected of a facultative pond in the summer, if a suspended solids content of 150 mg/l is assumed.

Table V. Estimated performance of algae-removal systems

System	Mean effluent SS,[a] mg/l
Microstraining	>60
Direct filtration without coagulants	>60
In-pond removal—series arrangement, continuous discharge	>30
In-pond removal with chlorination[b]	>30
Submerged rock filter[c]	<30
Centrifuge	<30
Intermittent discharge lagoons[d]	<30
Aquaculture	<30
Overland flow	<30
Coagulation-flocculation-sedimentation	10-30
Coagulation-flotation	10-30
Intermittent sand filtration	20
In-pond chemical addition to intermittent discharge lagoons[d]	<10
Coagulation-clarification followed by filtration	<10

[a]Assumes pond effluent suspended solids at 150 mg/l, except as noted.
[b]Accompanied with the release of BOD.
[c]Tentative ranking—full-scale testing to date is based on pond effluent suspended solids averaging less than 73 mg/l.
[d]May be limited to northern U.S. climatic conditions.

V. Equipment and Operations

The major item of equipment required for this work was a filter of significant size, yet convenient for transport to different locations. A survey of available off-the-shelf designs uncovered no single unit that met the criteria for operation and size.

To avoid special permit requirements, vehicles on Georgia highways must not exceed 8 feet in width nor 13½ feet in height. Most available units are rather tall, height (or depth, acutally) being of no particular concern in permanent installations.

The Georgia State Agency for Surplus Property had located for this project an Air Force flat bed trailer on which the filter and its auxiliary equipment was to be mounted. Although it was necessary to repair the brakes and lights of the trailer and to replace the tires, the result was an exceptionally useful unit provided at a small fraction of the cost of a new trailer.

Recognizing the height considerations, a modified version of a commercial design was suggested by Davco-Defiance, Thomasville, Georgia. The final plans of the system are shown in Fig. 11. This unit was mounted on the trailer along with a portable generator which had been obtained through the Georgia Agency for Surplus Property. This generator provided power for operations remote from power lines, and was essential to the project, although it was the source of difficulty from time to time. The gasoline tank was located above the engine, and it was necessary to exercise appreciable caution in transferring fuel to this tank, particularly when the engine was hot. The advantages of external power such as was available at Monroe, Georgia are tremendous, and external power appears almost mandatory for extended operation.

For operation of the unit, the trailer was positioned on the bank near the outlet structure of the pond. Such structures are typically of concrete and extend 15-20 feet into the pond. They are provided with weir adjustments, gates, or other devices for controlling the pond level and the rate of outflow. At each pond the submersible pump which supplied the filter was hung by a chain or cable from the railing of the outlet structure, and effluent pumped through a three-inch hose into the dosing box

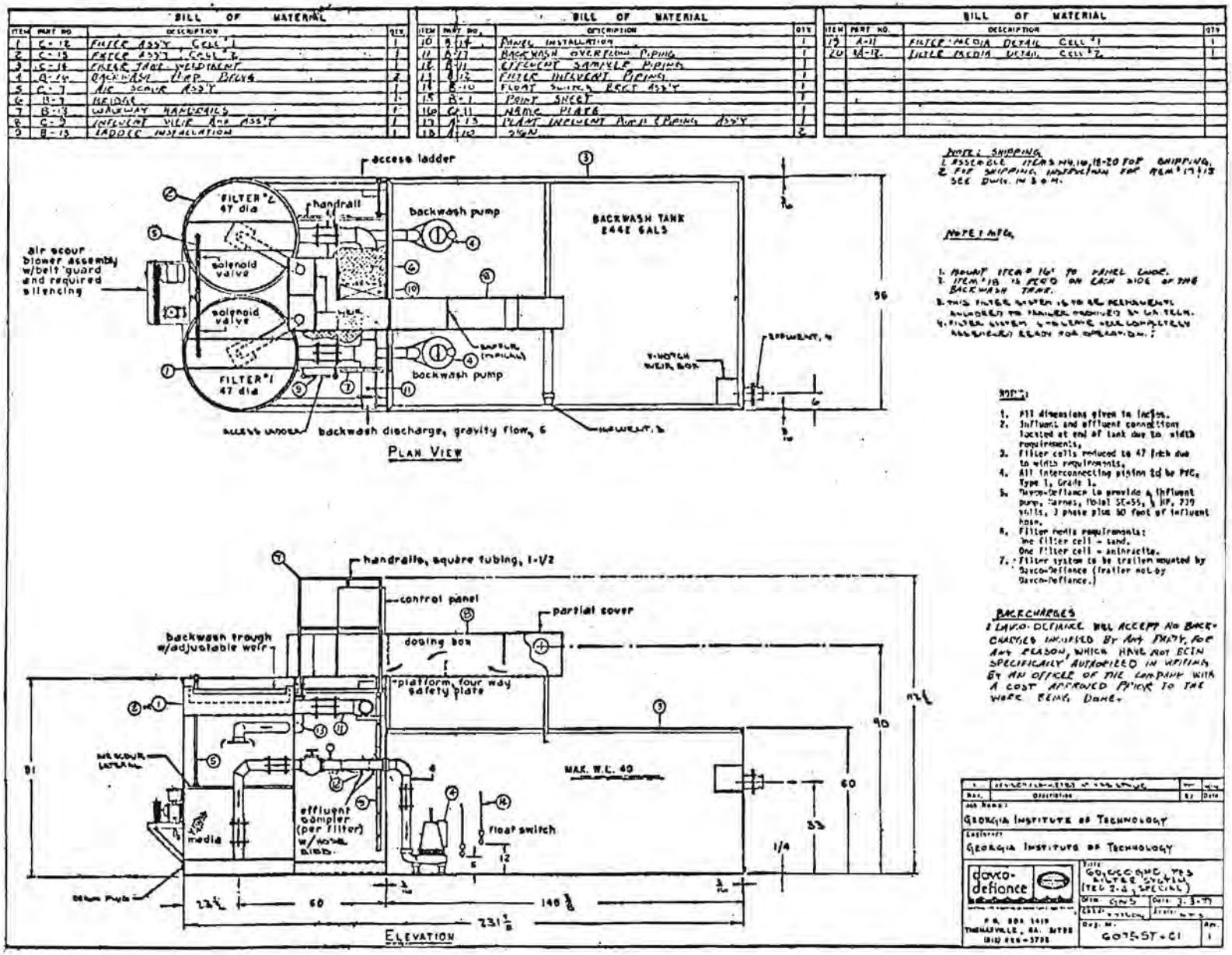


Figure 11. Plans of Filter System

located above the backwash tank. The capacity of the pump was adequate for all situations encountered, and a valve was later added to the dosing box inlet line so that the flow could be throttled when required for low-rate filtration experiments. Better control of the flow was obtained by adding two drain outlets to the dosing box. Hoses returned diverted flow to the pond. Very fine control could be obtained by adjustment of the valves which were located so that the operator could observe the flow depth at the weir and handle the valves simultaneously. Flow passed from the dosing box over v-notched weirs into the filters. The weirs were adjustable and could be moved to offset differences caused by lateral non-level conditions of the trailer. The trailer could be easily leveled front-to-back with the landing gear, but there was no provision for leveling in any other plane.

The depth of flow over the weirs was used for flow measurement, and the actual levels were measured with hook gauges constructed of small-diameter brass rod. Pointers at the upper ends of the rods gave convenient readings against small attached scales. Readings were converted to flows by use of a depth-versus-flow chart for $22\frac{1}{2}^{\circ}$ v-notch weirs.

In operation water was pumped from the pond, filtered, and passed into the backwash tank. When the tank was filled to the overflow outlet, subsequent filtered water exited the tank through a 4-inch diameter hose and was either returned to the pond or released to the stream receiving the pond effluent.

Backwash of the filters could be initiated in three ways: at intervals preset on a control timer, by high water level in the filter which tripped a limit switch, or manually. It was not possible to ascertain with certainty what might have happened when the filter was running unattended overnight or during other extended periods, so a strip-chart recorder was added. Through relays, this recorded the times when either of the backwash pumps were in operation, thereby providing a written record of times and intervals between backwash for each filter.

The backwash sequence consisted of an air scour followed by reverse flushing of the filter with the wash water being collected in the backwash trough and returned to the pond. This sequence was then repeated for the second filter. The control system was the source of some difficulty, on occasion initiating undesired backwash for no discernable reason. It was

therefore deemed preferable to operate manually when possible, and leave the automatic operation to periods of unattended operation. The only disadvantage of the manual backwash was that the air scour could not be used due to lack of manual controls on the valves controlling the air. This was not of significant concern, however, as there did not appear to be any discernable difference in results with or without the air scour.

Two 20-gallon feed tanks and high-pressure chemical feed pumps were later added so that alum and polymer solutions, controlled separately, could be added. The feed point was through copper tubing into a specially constructed fitting which was installed in the hose leading from the submerged pump to the dosing box. This proved to be a very satisfactory arrangment due to the precise adjustments that were possible with the feed pumps. This was much better than an earlier arrangement in which solutions were fed from the tanks and allowed to drip directly into the dosing box. The results obtained were evaluated by determination of suspended solids. Samples were filtered on site through weighed filter papers and were then returned to the laboratory (or motel) for drying and reweighing. A three-place manifold and vacuum pump was used to accomplish the sample filtration within a reasonable length of time.

The sample size was normally 300 ml but an occasion the filter became plugged with the suspended matter, and smaller samples had to be used. A high quality analytical balance was used for all weighings, and the results are believed to be quite accurate. The uncertainty of weights is considerably less than variations in the samples collected directly from the pond where solids concentrations fluctuate widely. Samples of filtered water were obtained directly from the filter effluent lines through sample lines that were provided.

Figures 12 through 17 are various views of the filter in operation at several locations where work was performed. The arrangements were essentially the same in each case except at Ashburn where the configuration of the gate and driveway made it impossible to get the trailer inside the fence. In this instance the trailer was backed through the gate as close as practical to the edge of the pond. The submersible pump was placed in a large wash tub to prevent uptake of bottom sediments and positioned a few feet away from the bank of the pond. This arrangement worked quite well, although samples of pond water could not be collected at the pump. They were actually taken from pond effluent at the outlet structure some 60 meters away.

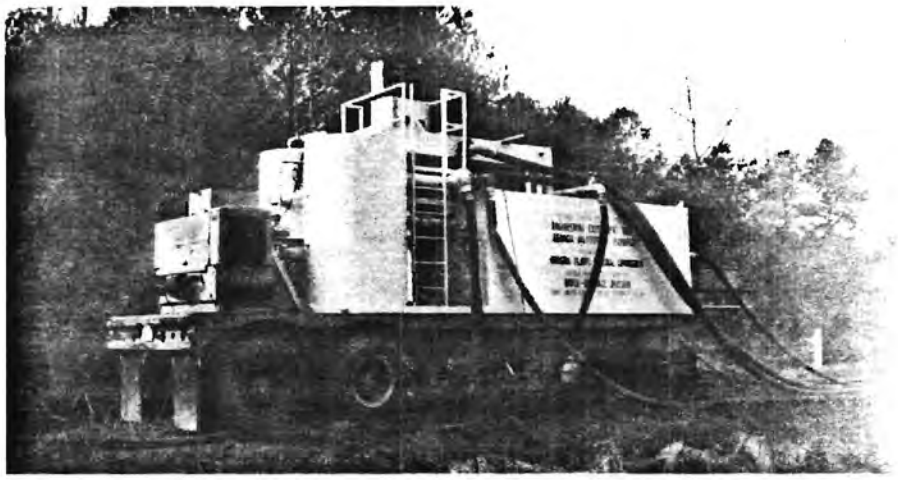


Figure 12. General View of Filter Operation

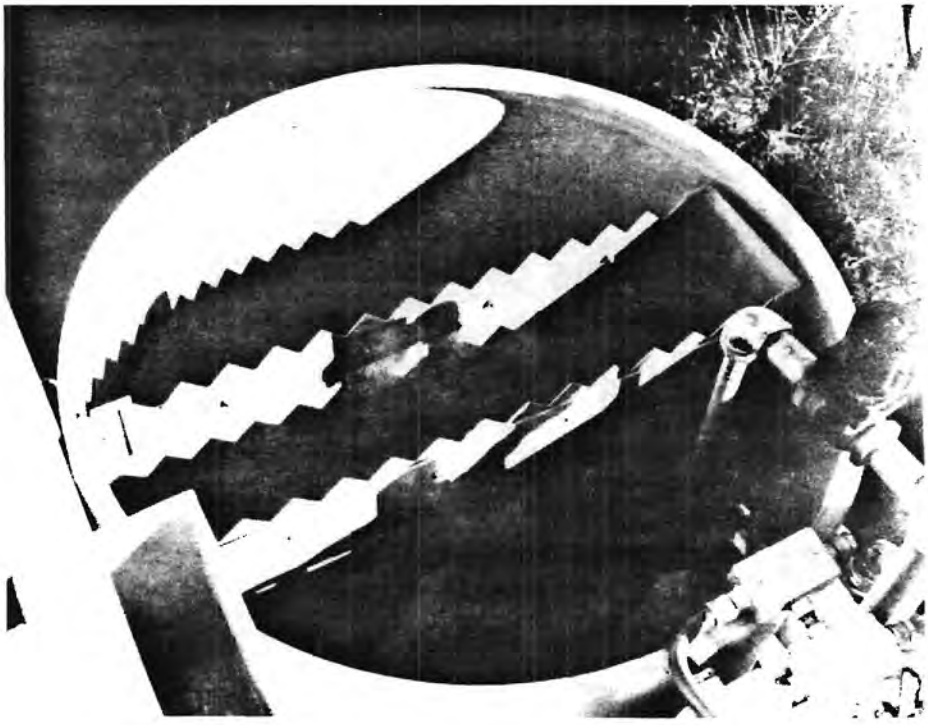


Figure 13. Top View of Filter Showing Backwas Trough with V-Notch Weirs

Figure 14. View of Filter on Location in Monroe, Georgia

Figure 15. Filter Situated at Outlet Structure of Hazlehurst Pond

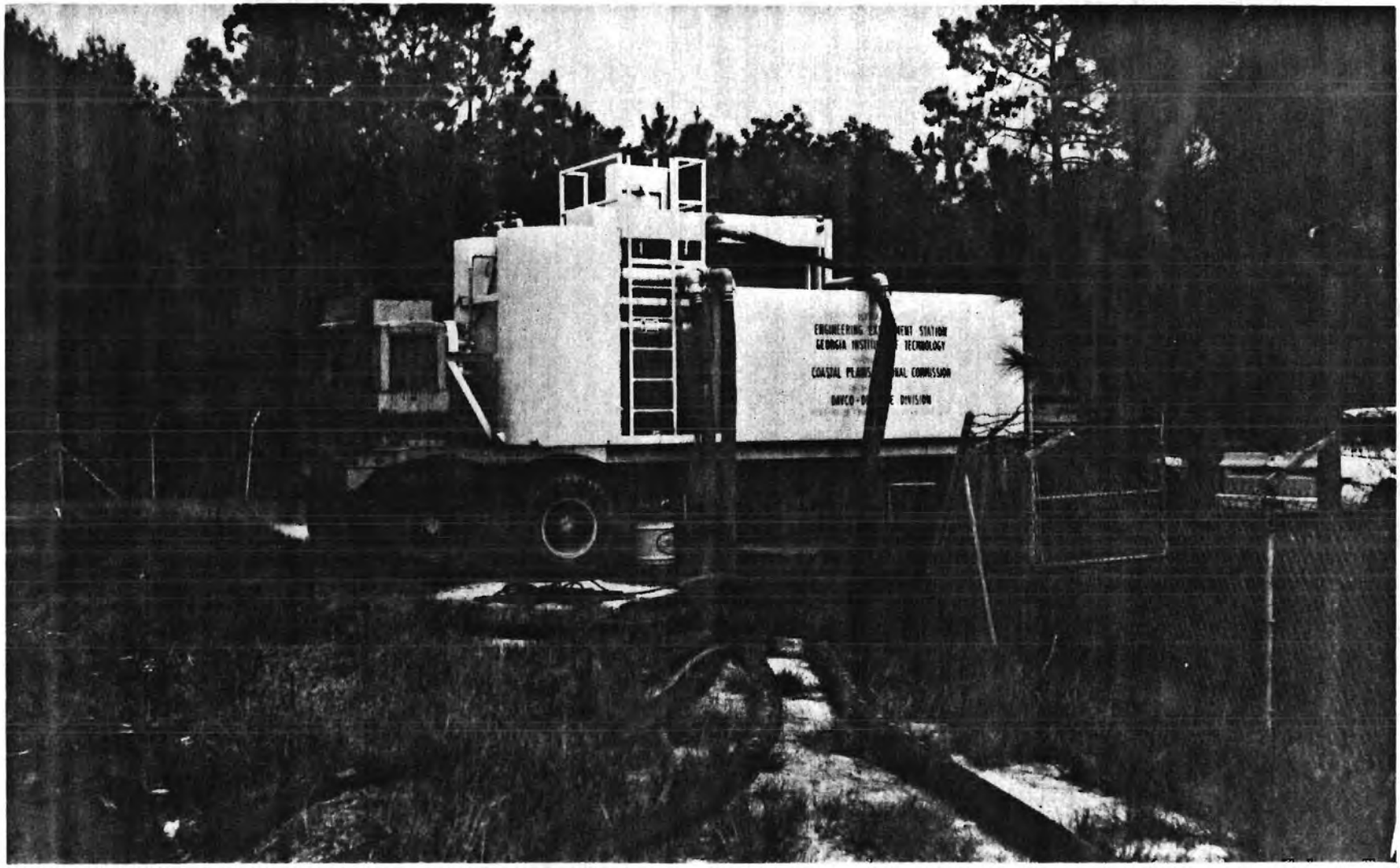


Figure 16. Operational Configuration of Hoses

Figure 17. Equipment on Site at Ashburn, Georgia

VI. Sites of Operation

In selecting sites for operation, a number of candidate locations throughout the state were visited. Some were immediately rejected due to inaccessability to the trailer, close proximity to dwellings whose inhabitants might be disturbed by the continuing sound of the generator engine, and other logistical considerations. For the most part, the officials in charge of wastewater operations, city managers, mayors, and others with whom this project was discussed were anxious to have work done at their pond. It was carefully explained that benefits might accrue, and the cost to the community would be no more than some manpower to assist in setting up and later repacking the heavy hoses that were used. The only exception was the mayor/banker who advised that his pond worked to perfection, his consulting engineer needed no additional information, and that he should be left alone. This wish was promptly granted.

The first site chosen for operation was the Clayborn Manor Pond, located near Duluth, Gwinnett County, Georgia. As shown in Fig. 18, this was a two-cell facility consisting of basins with surface areas of 3.45 acres and 1.47 acres. It served a large subdivision, several churches, and a large elementary school, but no industry. This facility has subsequently been eliminated, and the previous flow to this pond is now carried through a newly constructed sewer to a treatment plant several miles away. Some analytical data on this pond is shown in Table VI. It is believed that the values given here are typical of ponds of this type located in this general area.

The Mountain Creek Pond is one of several that serves the city of Monroe, Walton County, Georgia. It receives flow from a municipal population of about 3500 plus a chicken processing plant which contributes about 0.5 MGD of flow when in operation. The pond system consists of three cells, the first of which, 4.5 acres in area, contains three 25 HP and four 20 HP floating aerators. This arrangement provides the flexibility needed to match aeration with the quality and quantity of the influent. The second cell is five acres in area, and the final cell encompasses some 25 acres.

Table VII is a listing of analytical data on this pond for the year 1978. It can be seen that the suspended solids content of the effluent was

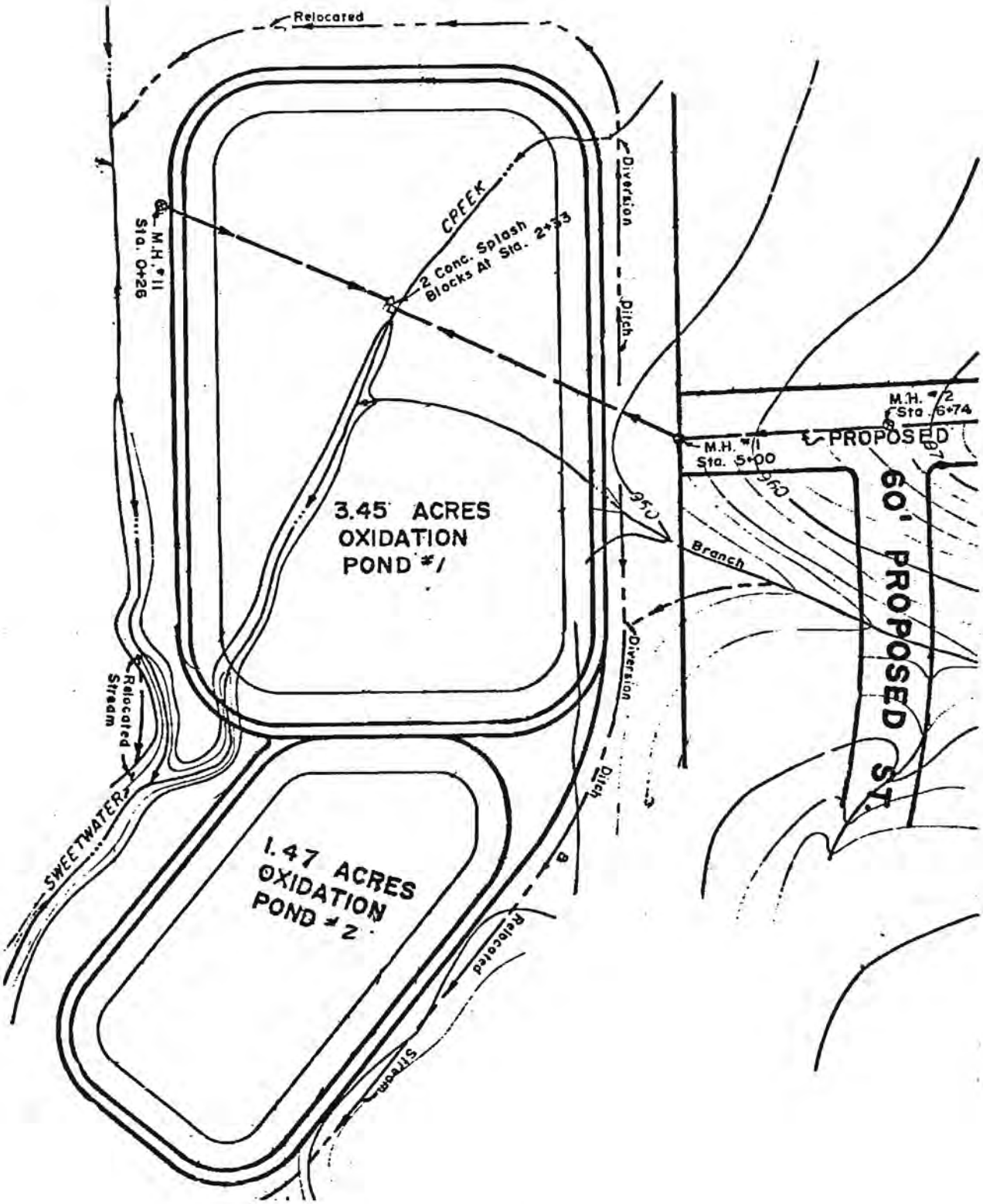


Figure 18. Map of Clayborn Manor Ponds

Table VI. Discharge Monitoring Reports:
Clayborn Manor Pond, Gwinnett County

Period	Flow MGD	pH Inf/Eff	BOD_5 Inf	BOD_5 Eff	% BOD_5 Removal	Suspended Solids Inf	Suspended Solids Eff	Suspended Solids % Removal
3-76			80	11	86.2	65.4	35.6	45.6
4-76		-/8.0	205	28	86.3	48	54	—
5-76			345	30	91.3	243	50	79.4
6-76		6.5/7.0	260	39	85	38	43	—
7-76		6.0/7.5	30	6	80	102	60	41
8-76		-/8.5	150	20	87	171	65	62
9-76		7.0/6.8	255	27	—	320	100	68
10-76		7.2/6.8	271	21	92	265	85	68
11-76			305	23	92	446	75	83
12-76		8.0/6.5	305	31	90	311	67	79
1-77		6.8/6.9	155	10	94	80	6.5	92
2-77	0.2552	6.8/7.5	185	18	90.3	81.9	36	56.1

Table VII. Discharge Mointoring Reports:
Mountain Creek Pond, Monroe, GA

Period	Flow MGD	pH Inf	pH Eff	BOD_5 Inf	BOD_5 Eff	% BOD_5 Removal	Suspended Solids Inf	Suspended Solids Eff	Suspended Solids % Removal
1-78	1.14	8.6		121	11	91	69	14	80
2-78	1.14	8.7		110	11	90	83	14	83
3-78	1.14	8.4		137	10	93	99	24	76
4-78	1.14	8.2		133	6	95	62	22	65
5-78	1.14	7.9		84	4	95	120	8	93
6-78	.755	7.6		149	8	95	133	21	84
7-78	.755	7.6		207	3	99	224	15	93
8-78	.755	7.7		179	7	96	175	18	90
9-78	.886	8.0		168	6	96	234	17	93
10-78	.721	7.5		137	4	97	125	16	87
11-78	.721	7.4		185	6	97	156	18	88
12-78	.721	8.1		174	14	92	154	25	84

consistently below the 30 mg/1 limit. This reflects the achievement possible when good design is coupled with knowledgeable operation. It was observed during the work, however, that there were frequent fluctuations in the solids content of the effluent and high values wer noted.

The Hazelhurst, Jeff Davis County, Georgia, Waste Stabilization Pond #2 is located outside the city limits adjacent to the golf course of the Jeff Davis Country Club. It is a well-designed two-cell facility serving approximately 2500 people. Some commercial establishments are included, but there is no significant industrial waste flow to this pond. Through strategic placement of a baffle, flow is advantageously maximized in the larger first cell which has an area of 9.14 acres. After traveling the length of the basin twice, the flow enters the 4.28 acre second cell near one end, and exists near the opposite end.

Shrubbery along the fence nearest the golf course helps obscure the view, although the well-kept grounds are aesthetically very pleasing. A number of ducks as well as other species of birds were in evidence much of the time that experiments were in progress. As with most ponds, odors on occasion are troublesome. The mats of green and blue-green algae that form are broken up with jets of water from fire hoses that are fed from the pond by a portable gasoline engine powered pump. This pump is positioned as needed, and is very effective in dispersing the algae.

The results of the operation of this facility for a recent 14-month period are summarized in Table VIII. This pond is typical of many of the non-aerated facultative ponds in the coastal plains region. The effluent was frequently near or below the 30 mg/1 limit, but on only one occasion did the valve exceed the 90 mg/1 valve which would be applicable to this facility. The occurence of a single high valve is generally the result of some unusual circumstance. In the case of the August, 1978 report, it is believed that the high suspended solids valve was due to scouring of the pond by a flow rate that was exceptionally high for that season of the year.

The West End Water Pollution Control Facility is located on West End Avenue in the city of Ashburn, Turner County, Georgia. It is a single cell, approximately square, with an area reported to be eight acres. Although exact figures are not available, it is believed that the domestic wastes of more than 2000 people are received by this pond. At the time of

Table VIII. Discharge Monitoring Reports:
Pond #2, Hazlehurst, Ga.

Month	Average Flow (MGD)	pH	BOD_5 (mg/ℓ) Inf	Eff	Removal %	Susp. Solids (mg/ℓ) Inf	Eff	Removal %
5-78	0.34	6.8	150	17	89	320	3	99
6-78	0.156	7.8	180	24	87	138	33	76
7-78	0.251	7.6	280	37	87	284	46	87
8-78	0.409	6.8	190	41	78	148	163	—
9-78	0.177	8.7	153	31	80	124	16	87
10-78	0.136	7.7	125	23	82	152	34	78
11-78	0.118	8.0	135	31	77	88	24	73
12-78	0.409	7.8	230	17	88	104	6	94
1-79	0.308	8.8	90	20	78	184	74	60
2-79	0.278	6.9	146	26	82	232	38	84
3-79	0.768	6.8	90	42	53	151	23	85
4-79	0.340	6.8	135	62	54	160	66	59
5-79	0.340	7.1	128	26	80	204	26	87
6-79	0.278	8.5	128	30	77	117	58	50

the work period at this location (August-September, 1979) the pond was in rather poor condition. Emergent weeds were thick in the shallow edges of the water and the grass was need of cutting. The edges of the pond have suffered erosion, and small cave-ins at different spots present an uneven appearance.

A floating mat of algae, perhaps one-half acre in area, was present. It was primarily green, with only traces of blue-green. No objectionable odors were noted, although the wind direction was toward the area of operation. Algal mats are combated with a small motor boat, which is used to stir and break up the accumulated floating material. When this is done frequently, there is little odor problem, and complaints are infrequent. The performance of this pond is probably simular to many in the area, and is best described by the monthly Discharge Monitoring Reports which are summarized in Table IX. It may be seen that the 30 mg/l suspended solids figure was not met during this period, and four values exceeded the 90 mg/l level. This is clear evidence that the pond is not performing in a satisfactory manner, a situation believed due to overloading. This matter is already in the hands of a consulting engineer, and relief is being planned.

Table IX. Discharge Monitoring Reports:
West End Pond, Ashburn, GA

Period	Flow MGD	pH Inf	pH Eff	BOD_5 Inf	BOD_5 Eff	% BOD_5 Removal	Suspended Solids Inf	Suspended Solids Eff	Suspended Solids % Removal
6-78	0.222	7.0		140	54	61	124	103	17
7-78	0.096	7.1/7.4		180	60	67	148	108	27
8-78	0.316	8.3		160	28	82	160	62	61
9-78	0.177	7.0		180	28	84	130	85	35
10-78	0.096	7.4		120	22	82	148	49	67
11-78	0.177	7.6		170	48	72	150	86	43
12-78	0.177	7.4		210	30	86	190	46	76
1-79	0.544	8.1		100	26	74	82	56	32
2-79	0.538	7.3		260	30	88	226	74	67
3-79	0.250	7.1		160	30	81	146	36	75
4-79	0.2966	8.5		260	28	89	213	69	68
5-79	0.246	8.0		340	42	88	452	68	85
6-79	0.2966	8.7		160	22	86	114	103	10
7-79	0.4344	7.5		90	40	56	91	114	—

VII. Results and Discussion

The suspended solids content of pond water is a widely fluctuating variable, and under the conditions usually existing during the work described here, consecutive samples were unlikely to give results in very close agreement. While there is some theoretical averge value, it is evident that the solids content of ponds are not normally very evenly distributed. There is a vertical distribution due to the customary physical and biological consequences of pond functioning, but in addition there is a horizontal distribution due to inlet and outlet placement and to flow patterns. Superimposed on these conditions is the effect of the immediate environment. Thermal effects are readily noticeable, and wind effects are often clearly visible even to the casual observer. The result is that analysis of a single grab sample should be regarded as indicative of existing conditions rather than as an absolute, fixed value. In consequence, the approach taken here has been to average the values of samples taken over a period time.

At times there was observed a variation in the quality of filter effluent that corresponded to change in the quality of the pond effluent, but this was usually a more gradual effect, due to the leveling out of rapid change by the mixing and period of storage that was provided by the filter container itself above the surface of the filter medium. It was not uncommon to observe effluent values that were higher than corresponding pond values, particularly when the removal effectiveness was not very high. This condition is illustrated by Fig. 19 which is typical of the results obtained using no coagulant with filtration through the sand and anthracite media which were supplied with the filter.

Obviously such a filtration would be of no value, as little change was being produced by passage of the water through such coarse media. The actual particle size distribution of the sand was determined by screening, and the result is shown in Fig. 20. The effective sand size of 0.76 mm was far too large to allow capture of the very small algae present. As little solid matter was being collected in the filters, the increase of bead loss was very slow, and extended filter runs of several days could have been made.

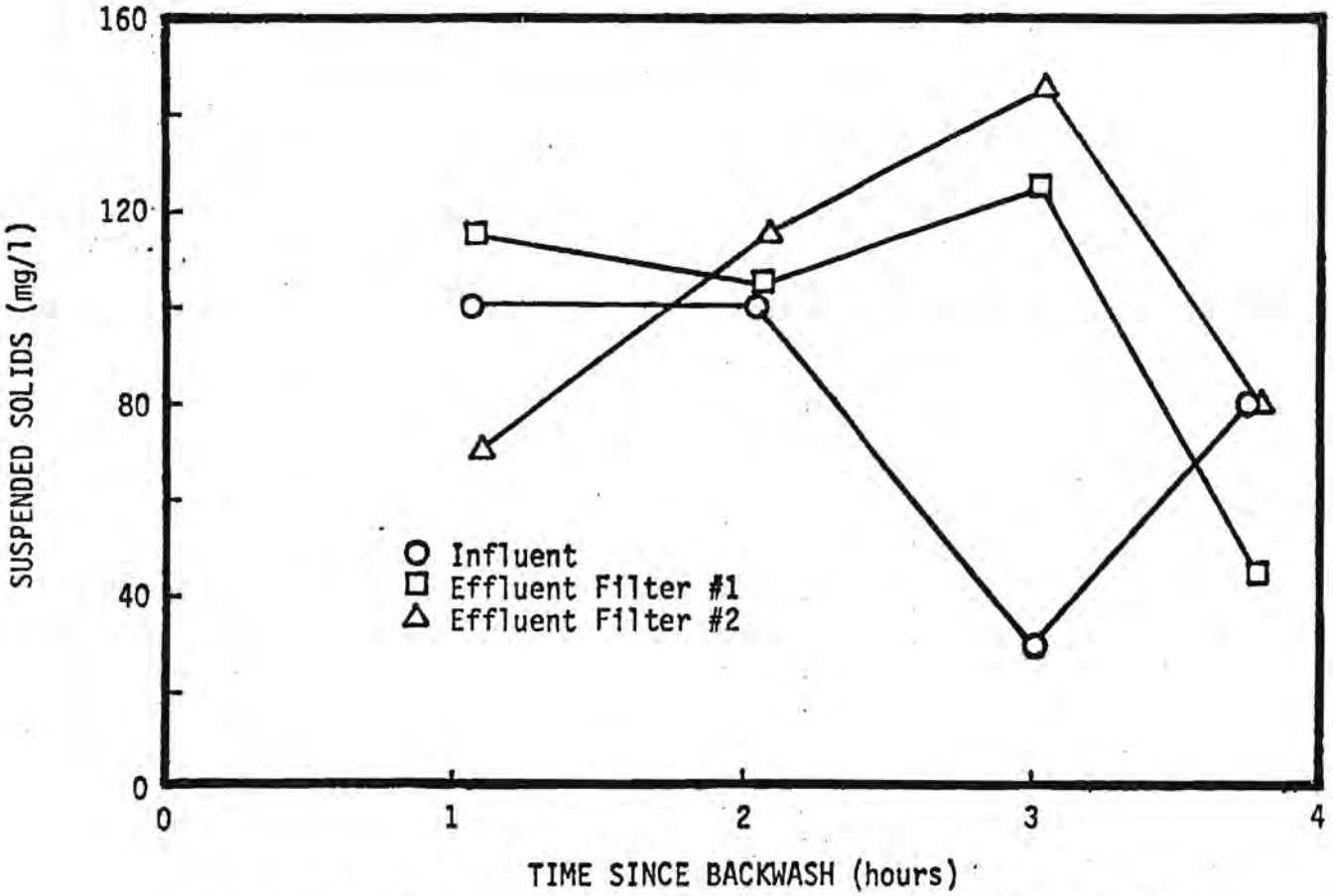


Figure 19. Suspended Solids Concentration of Filter Influent and Effluents

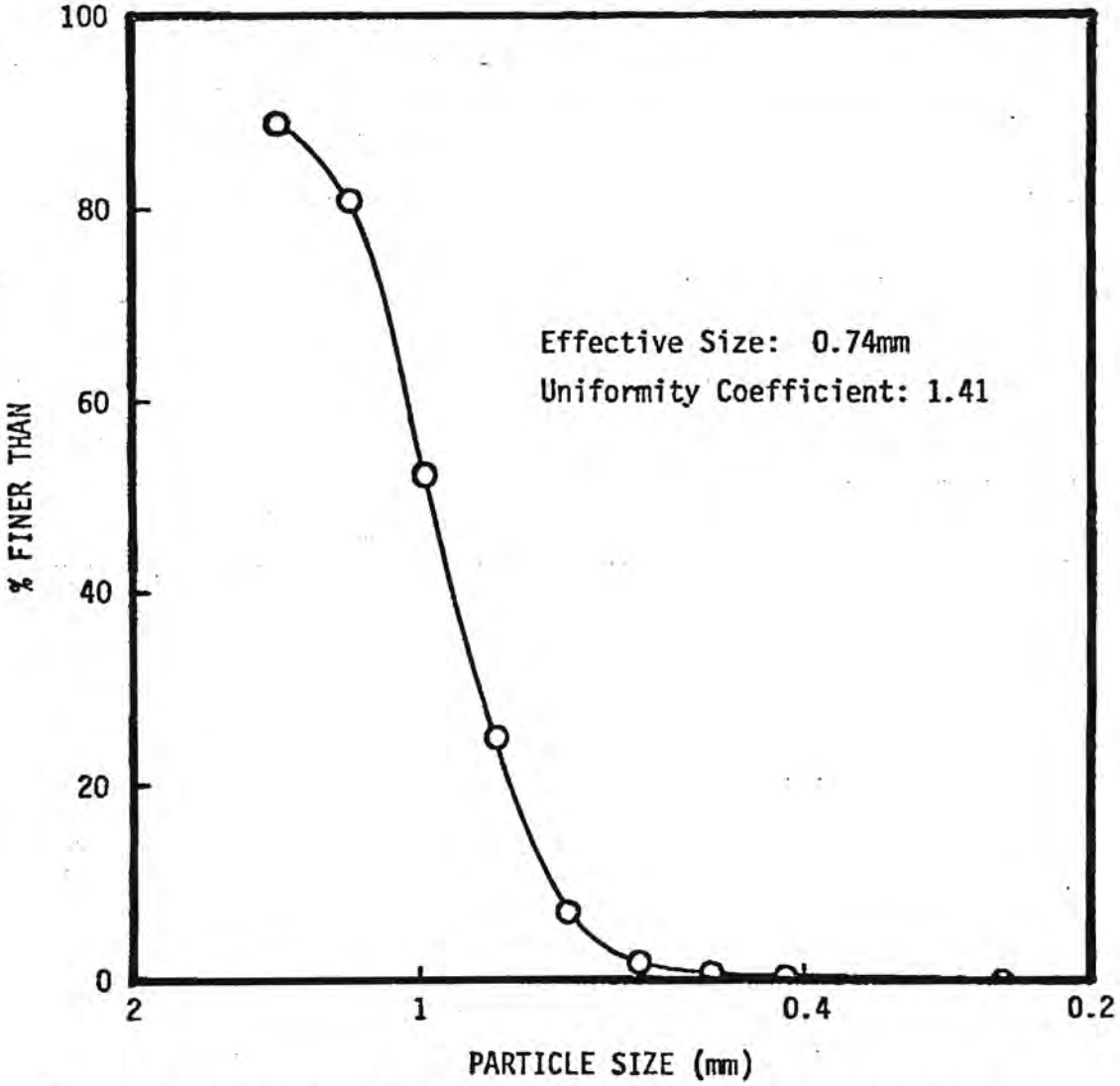


Figure 20. Particle Size Distribution of Initial Sand

The change of a complete filter bed was a logistical problem of considerable magnitude. The dimension of the filter limit the practicality of using a shovel, and no suitable pump with appropriate capacity to empty the filter while fluidized by backwash was available. Therefore, instead of total replacement of the sand the particle size distribution was altered through addition of sand of small particle size. A commercially available product, "Minus 30 Sand-Blasting Sand", was added to the filter bed. The particle size distribution of the thoroughly mixed bed is given in Fig. 21. Although this was a contrived distribution, it had an effective size of only 0.175 mm, in contrast with the previous value of 0.76 mm.

A number of runs were made following addition of the fine sand, and solids removal were greatly enhanced. As may be seen in Fig. 22, influent values in the order of 120 mg/l could be consistently reduced to the 30 mg/l range. Runs such as this are fairly satisfactory from the standpoint of solids removal, but only short runs were possible, even at low flow rates, and quality of the effluent worsens after only a short period of time. Figure 23 illustrates this effect. It was observed here as well as at later times that it is the total quantity of water filtered that determines the need for backwash; it is relatively independent of the flow rates. There is, however, a degradation of effluent quality as flow rate is increased. Even though a wide range of flow rates was evaluated, it was never possible to filter through this bed an acceptable quantity of water beyond what was required for backwash. As a consequence, the technique of direct filtration without coagulant was altered, and subsequent investigation used the concept of coagulation prior to filtration.

Extensive evaluation of alum and various polymers, individually and in combination was carried out. It was noted immediately that the fine-grained sand bed produced very short runs in the same manner as without coagulant; it was clear that the medium was much too fine for coarse floc. The use of a coarser medium would allow some penetration of solids into the bed thereby providing additional storage volume for the trapped solids and allowing longer filter runs. Otherwise, the large flocs would accumulate rapidly on the surface causing rapidly increasing head loss.

The particle size distribution of the sand bed was modified by backwashing at a very high rate. The finer particles were readily washed out

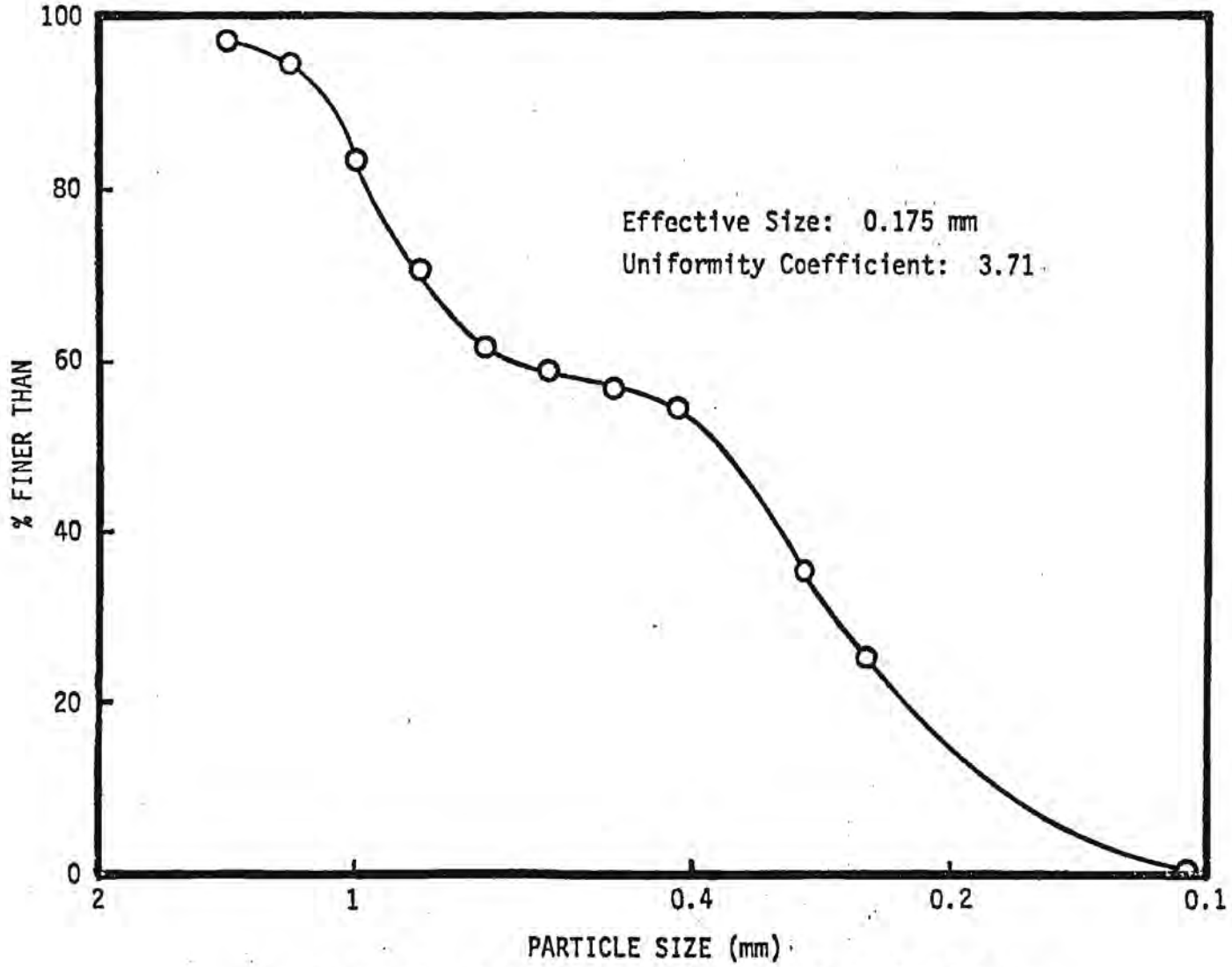


Figure 21. Particle Size Distribution of Sand Bed After Adding "Minus 30 Sand Blasting Sand"

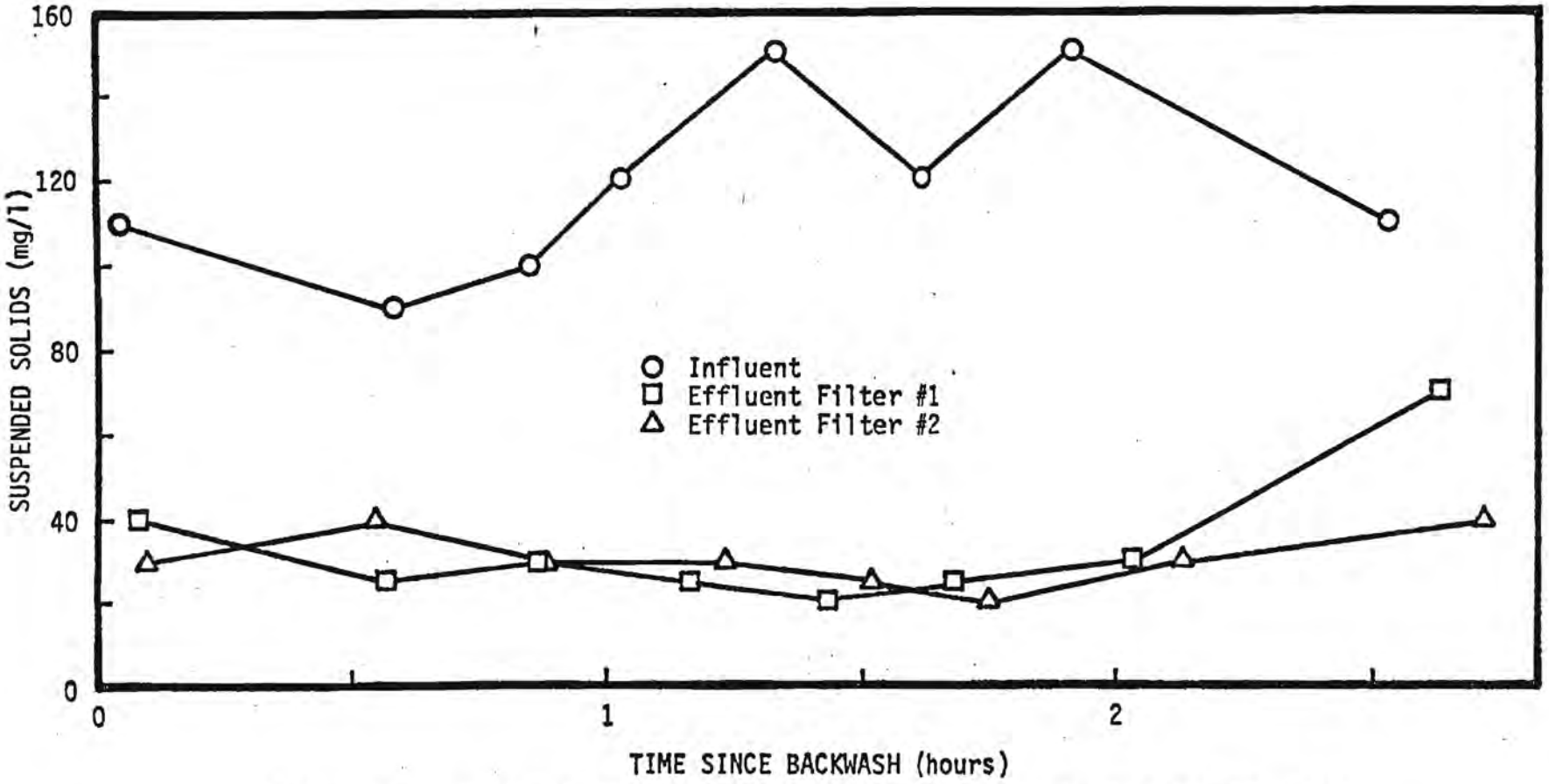


Figure 22. Suspended Solids Concentration of Filter Influent and Effluents

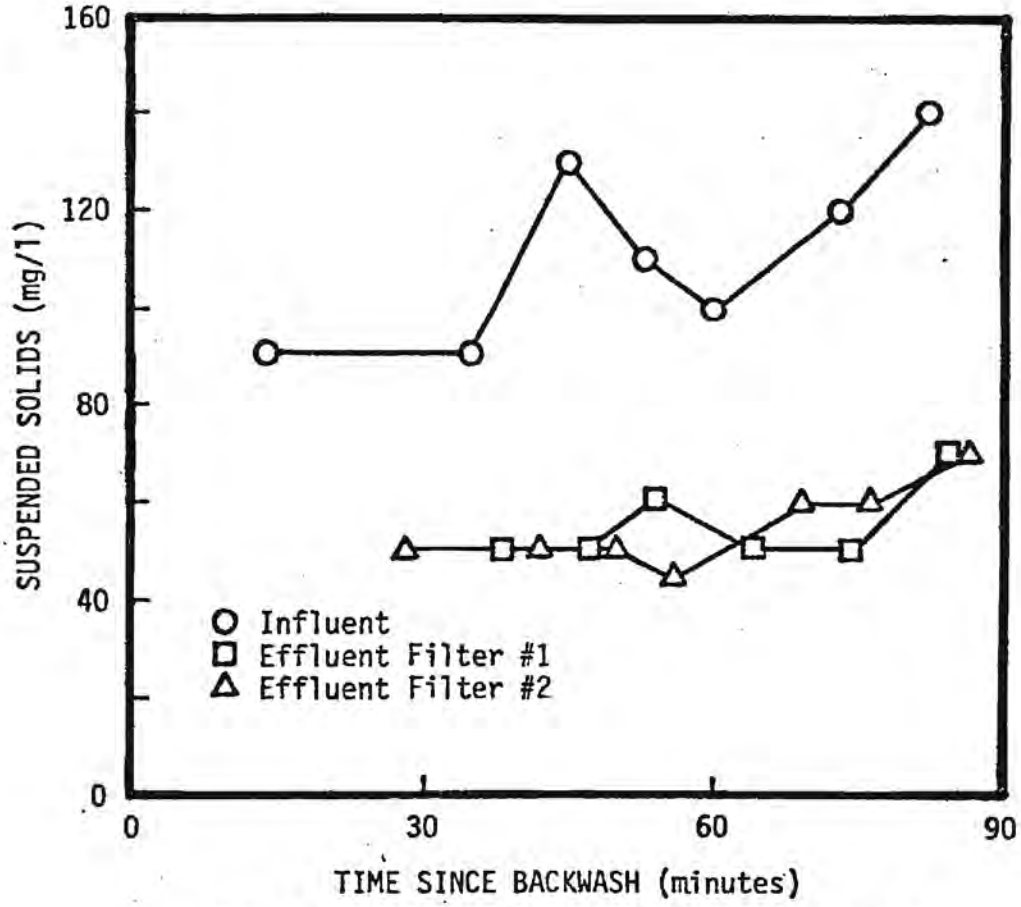


Figure 23. Suspended Solids Concentration of Filter Influent and Effluents

by this procedure, and the length of subsequent filter runs increased immediately. At a later stage in the work, the sand filter was converted to a dual media filter by removal of a portion of the sand followed by addition of coarse anthracite. The particle size distribution of this anthracite was determined as shown in Fig. 24. The effective size was found to be 1.45 mm and the uniformity coefficient was 1.56. As may be seen from data presented below, the dual media arrangement routinely provided filtrate that equaled or surpassed that of the anthracite alone. It was only infrequently that even a single value for anthracite alone was better than for the dual media, although for much of the work the results were about the same.

Most of the data collected during this study is summarized in the tables which follow, and each shows the conditions of the run along with the concentration of suspended solids in the filter influent and effluent. The chemical feed system consisted initially of a 25-gallon drum from which solution could be injected into the filter influent hose by an adjustable high-pressure feed pump. A second tank and pump were soon added to the system, however, in order to provide independent adjustability of the alum feed and the polymer. Some runs were made, however, with a single pump system injecting mixed solutions of alum and polymer.

The results achieved by use of alum alone are displayed in Table X. As a starting point, two runs are included here which involved no coagulant; the first, run 3-29, produced no change in suspended solids the when liquid passed through the anthracite filter. Some effect is indicated in run 5-3 where the liquid was passed through the dual-media filter. As noted above, at this stage of the operation, the fine sand was gone from the sand filter and all subsequent filtration involved the coarser media appropriate to the coarse alum floc that was to be the normal type of matter to be captured in the filter. From the remaining entries in this table, it may be seen that the use of alum alone at the indicated levels of introduction always reduced the suspended solids level, but never produced the very low values that were later obtained from combinations of alum and polymer.

This is probably due to the manner in which the filter unit itself was constructed and operated. It appeared that the length of time between alum injection and actual filtration was much too short for maximum

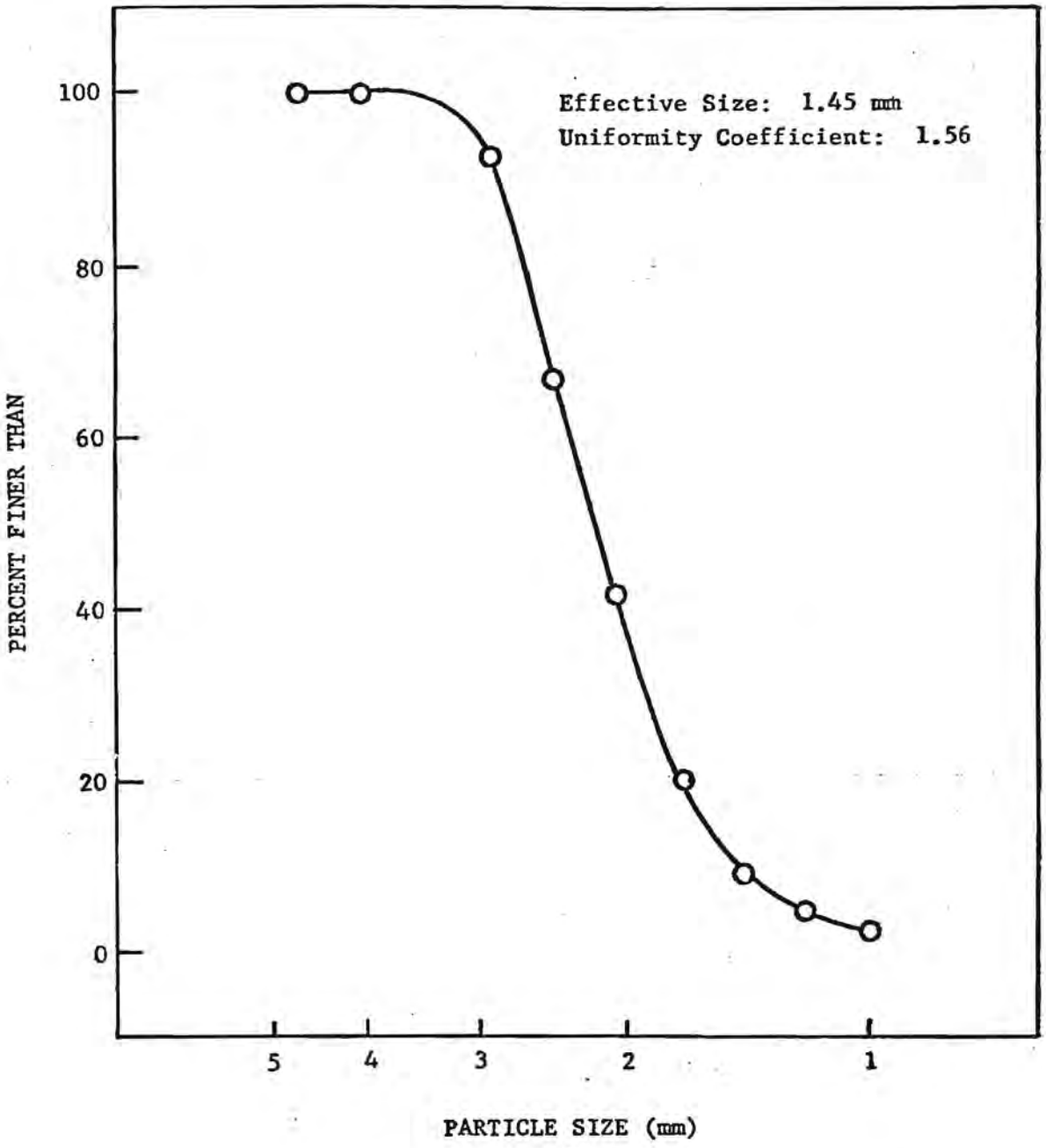


Figure 24. Particle Size Distribution of Anthracite

Table X. Filtration with Alum

Run	Suspended Solids mg/ℓ Inf	Eff	Alum PPM	Flow ga/ft^2/min	Filter Medium
3-29	80	80	0	1.5	Anthracite
5-3	66	48	0	1.4	Dual
9-28	42	21	8	3.0	Dual
	42	27	8	3.0	Anthracite
6-6	59	40	10	1.3	Sand
4-6	95	50	12	1.6	Anthracite
4-13	70	49	13	1.4	Sand
3-24	35	25	15	1.0	Anthracite
3-31	63	38	20	1.5	Anthracite
4-14	88	35	25	1.4	Sand
5-3	38	17	32	1.4	Dual
4-17	80	29	38	1.4	Sand
5-18	42	22	67	1.4	Dual

efficiency, and additionally put the entire floc load on the filter. At high flow rates it was noted that floc occasionally was visible in the washwater tank, indicating that the water had already passed through the filter before floc formation and growth was complete. There is also to be noted frequent instances of what appear to be inconsistent results, but in this case as with other biologically active systems the precise cause of variation is not readily attributable to a single factor. A case in point is a comparison of runs 9-28 and 5-18 where influent concentrations were identical. In this instance, a low alum feed and high flow produced the same effect as a much higher alum feed rate and lower flow rate, which is opposite the effect normally encountered.

The use of a polymer as a filter aid in conjunction with alum and by itself was studied. A number of samples were obtained from several manufacturers, following detailed discussion of the project needs and the properties of the various polymers that are available. A series of preliminary tests of those polymers was carried out in the laboratory in a test filter which was constructed of a 4-inch diameter plastic tube five feet in length. Dual media were installed, and a backwash arrangement was provided.

The experiments were performed by adding suitable quantities of the polymer to pond effluent that had been transported to the laboratory. The effectiveness of the polymer was judged by the solids content of the effluent, and by comparison with that of the influent. It was deemed necessary to use only pond water that was collected on the same day in order to correlate as closely as possible conditions in the laboratory and in the field. In general, the correlations were not very satisfactory, although there was a qualitative relationship. In several cases certain materials that showed promise in the laboratory were completely ineffective in the field. The products that were chosen for more extensive testing are listed in Table XI. Their properties are described in detail in literature supplied by their manufacturers. This information is reproduced here in Appendix B.

To evaluate the possibility of rejecting a desirable material on the basis of laboratory studies that might be shown to lack proper correlation, a few additional polymers were run in the field in spite of their poor laboratory showings. In this type of situation the correlation was

Table XI. Polymers Tested in Filtration Runs

Polymer	Manufacturer
Nalco 7103	Nalco Chemical Company
Nalco 7132	" " "
Nalcolyte 7105	" " "
Nalcolyte 7107	" " "
Nalcolyte 7134	" " "
Purifloc 31C	Dow Chemical Company
Magnifloc 581C	American Cyanamid Company
Magnifloc 1839A	" " "
Magnifloc 2535C	" " "

high-poor laboratory results gave poor field results. The results of some of the field tests with polymer alone are given in Table XII. The general range of concentration was usually about what the manufacturer suggested. Specific recommendations are seemingly seldom made with respect to feed levels, the usual practice being to select a material and then adjust to the minimum feed rate that will accomplish the desired result.

Nalco 7103, a pollution control coagulant recommended for use at a level of 2 to 50 ppm, showed a fairly satisfactory result in the laboratory and was therefore tested in the field. The best results obtained are shown in Table X as runs 6-30 and 6-29. In other runs, from influents whose suspended solids levels ranged from 40 to 130, it was possible to obtain effluents in the 20-40 range with an occasional value even lower when 7103 was added at rates up to 50 ppm. When tested in combination with alum, results were not appreciably better, even at feed rates of alum up to 50 ppm. Experiments and tests involving Nalcolyte 7134 gave similar results. The results from use of other products tested in the laboratory and field are given in the same table.

The enhancement of results when alum is used in combination with some polymers is shown by comparison of Table XIII with Table XII. With

Table XII. Filtration with Polymer

Run	Suspended Solids mg/ℓ Inf	Eff	Polymer	Feed PPM	Flow ga/ft^2/min	Filter Medium
5-9	75	51	C31	0.5-2	1.4	Sand
5-10	73	51	C31	2	1.4	Sand
5-10	58	56	1839A	1	1.4	Sand
5-11	81	62	1839A	5	1.4	Sand
5-8	97	84	2535C	5-10	1.4	Sand
5-5	109	55	2535C	1-4	1.4	Sand
6-30	71	45	7103	10	1.6	Anthracite
6-29	116	22	7103	19	1.6	Anthracite
7-5	127	72	7105	10	1.6	Anthracite
7-5	108	110	7105	19	1.6	Anthracite
5-6	202	218	7107	20	1.6	Anthracite
5-12	81	90	7107	20	1.5	Anthracite
7-13	38	27	7132	39	1.8	Anthracite
7-18	72	38	7134	40	1.6	Anthracite

Table XIII. Filtration with Alum and Polymer

Run	Inf	Eff	Alum PPM	Polymer	Polymer PPM	Flow	Filter Medium
5-22	28	17	60	C31	0-11	1.4	Dual
5-23	28	15	15	C31	3	1.4	Dual
5-24	52	24	15-30	C31	3-6	1.4	Dual
5-25	28	7	24	1839A	0.5	1.0	Dual
5-30	51	20	24-48	1839A	0.5-1	1.4	Dual
5-17	41	33	12-50	1561C	1-5	1.4	Dual
7-12	120	97	10	7107	4	1.5	Anthracite

the exception of run 7-12, the alum addition gives a final result significantly lower than the polymer alone. Runs 5-25 and 5-30 show satisfactory results, but in this instance the enhancement is probably due to the alum counteracting the anionic polymer, and thereby destabilizing the algae so that coagulation and subsequent removal by filtration can take place.

Of the various polymers that were used during this study, the most effective polymer found was Magnifloc 581 C. Consequently, many runs were made with this material both alone and in combination with alum. Table XIV shows the results of adding 581 C alone at rates of 4 to 32 ppm. There is a considerable variation in the suspended solids content of the effluents, but there is generally a good solids reduction, and at times an excellent reduction.

The situation improves significantly when the 581 C is used with alum. In the tabulation of results using this combination (Table XV) it may be seen that only two effluent values exceed 28 mg/l, and one of those (anthracite filtration, run 9-29) is offset by the lower value of the same liquid when filtered through dual media. It therefore appears that almost

Table XIV. Filtration with Magnifloc 581C

Run	Suspended Solids mg/ℓ Inf	Eff	581C PPM	Flow	Filter Medium
9-21	108	50	4	1.4	Dual
	108	56	4	1.4	Anthracite
8-2	80	22	4.5	2.0	Dual
	80	30	4.5	2.0	Anthracite
8-3	86	38	4.5	2.2	Dual
	86	39	4.5	2.2	Anthracite
7-21	63	29	7	1.2	Anthracite
8-7	106	40	7	2.0	Dual
	106	46	7	2.0	Anthracite
7-25	48	16	10	1.0	Anthracite
5-12	90	52	10	1.0	Dual
	90	53	10	1.0	Anthracite
5-15	79	43	10	1.5	Dual
	79	62	10	1.5	Anthracite
8-9	80	22	12	1.8	Dual
	80	27	12	1.8	Anthracite
7-28	47	14	13	2.1	Dual
	47	20	13	2.1	Anthracite
10-4	34	8	24	1.3	Dual
	34	8	24	1.3	Anthracite
7-20	64	7	14	1.3	Anthracite
8-7	152	35	14	2.0	Dual
	152	55	14	2.0	Anthracite
9-21	153	32	16	1.4	Anthracite
8-1	58	13	22	2.1	Dual
	58	18	22	2.1	Anthracite
9-20	88	33	26	1.7	Dual
	88	38	26	1.7	Anthracite
7-19	63	1	27	1.6	Anthracite
10-3	40	7	29	3.0	Dual
	40	7	29	3.0	Anthracite
9-26	68	56	32	2.0	Dual
	68	63	32	2.0	Anthracite

Table XV. Filtration with Alum and Magnifloc 581C

Run	Suspended Solids mg/ℓ Inf	Eff	Alum PPM	581C PPM	Flow	Filter Medium
6-7	34	28	10	0.5	1.3	Sand
6-21	55	18	8	1	1.5	Dual
6-9	38	4	20	1	1.4	Sand
6-13	107	63	8-16	1-2	1.5	Dual
6-22	84	11	11	1.7	1.0	Dual
6-20	34	2	13	2	1.5	Dual
5-16	37	15	16	3	1.4	Dual
	37	15	16	3	1.4	Anthracite
6-23	81	28	13	6	1.0	Dual
6-27	33	15	20	9	1.2	Anthracite
6-26	39	17	20	9	1.5	Anthracite
10-6	38	7	10	16	1.5	Dual
	38	7	10	16	1.5	Anthracite
6-27	65	4	40	18	1.2	Anthracite
6-28	133	16	16	21	1.0	Anthracite
9-29	73	26	8	31	3.0	Dual
	73	42	8	31	3.0	Anthracite

any combination of alum and 581 C in the range listed would provide a satisfactory outcome for regular operations. In actual practice, incremental adjustment of the feed of both alum and polymer could lead to determination of the optimum combination to achieve the required level of suspended solids.

The variation with time of some of the parameters is most readily examined through a plot of the data. Figure 25, for example, illustrates the pattern of change that was typically encountered. Clearly the pond values were on a downward trend while effluent values seemed to be on the increase after about the first four hours. The values marked "weir" were from samples collected just behind the weir over which influent passed to flow into the filters. At this point the liquid consisted of water from the pond plus any chemical that had been added. Runs involving only polymer were usually characterized by very similar values for "pond" and "weir". When alum was one of the additives, the difference was quite marked, and reflected the presence of the alum floc that was being produced.

Figure 26 is a plot of values which involved 581 C alone. While the solids content of the influent was definitely being reduced, the level of the effluent was not particularly good. The use of alum in conjunction with the 581 C was, as noted above, generally advantageous, but in some instances, this was not the case. Figure 27 illustrates an erratic and unsatisfactory result of filtration through a dual media bed preceded by treatment with alum and 581 C. It has not been possible to assign an exact cause to results such as these which are distinctly contrary to the usual outcome, but fortunately do not occur very often.

In any event, solids contents of effluent can be reduced to almost any value desired if sufficient treatment chemicals are added. Figure 28 displays the results of adding massive amounts of both alum and 581 C. Such dose rates would be very expensive to maintain on a large scale, but they do produce exceptionally good effluent. In fact, these levels are much lower than even the more restrictive regulatory mandate, and ordinarily there would be no need to produce effluent of quality this high.

Following completion of the work described above, the field equipment was moved to Hazlehurst, Georgia and then to Ashburn, Georgia for tests to verify the general conclusions developed primarily at Monroe,

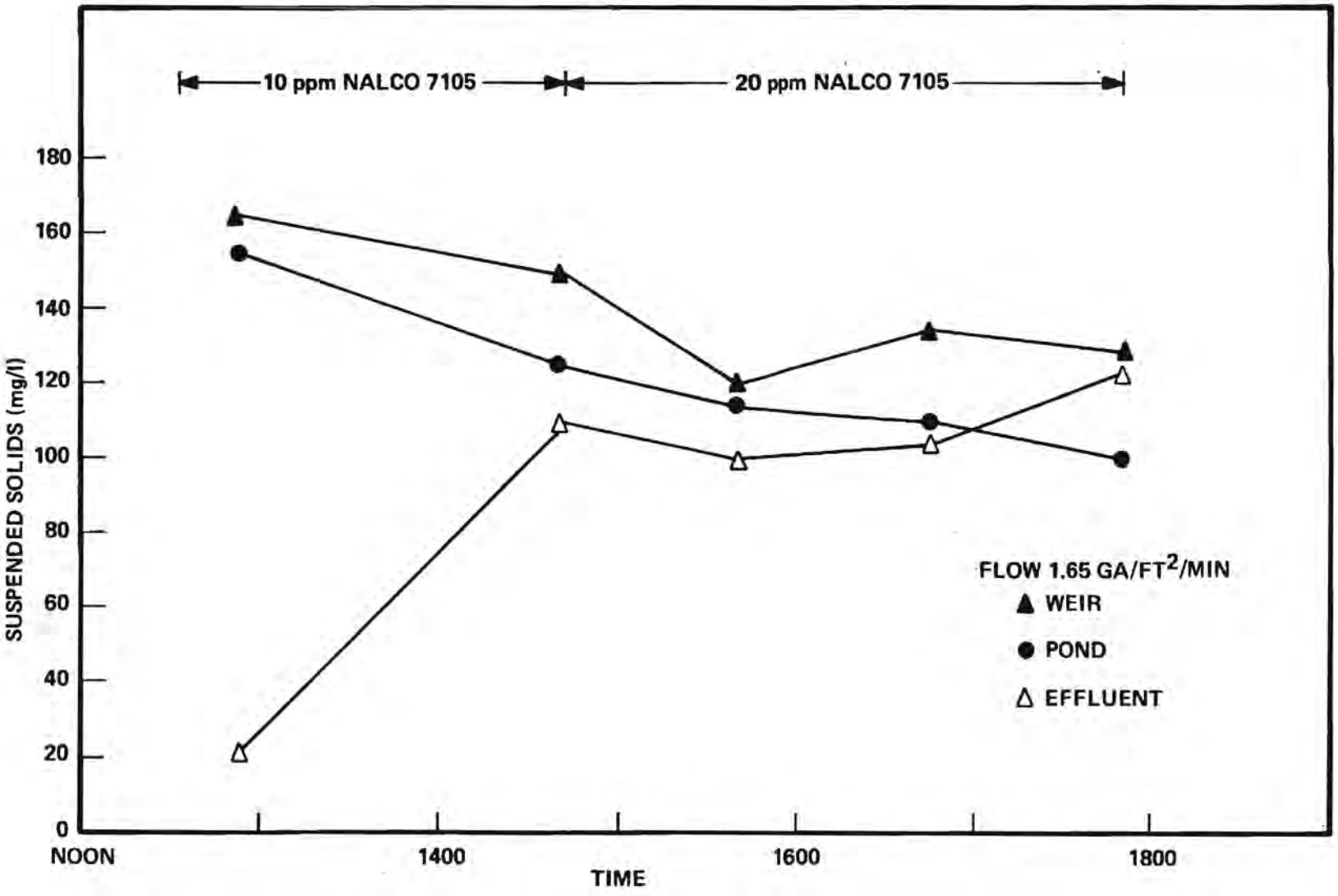


Figure 25. Filtration with Nalco 7105

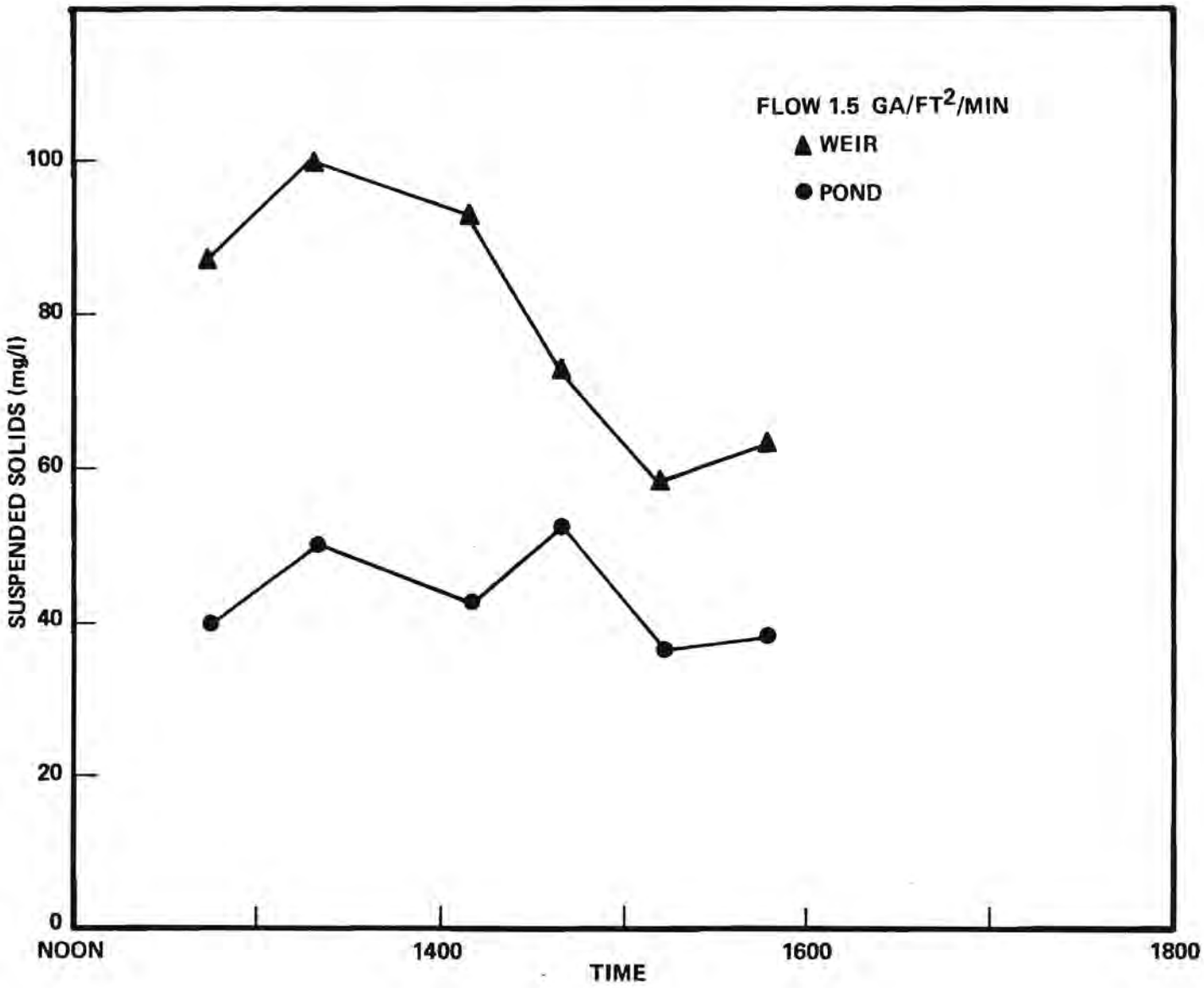


Figure 26. Filtration with Magnifloc 581C

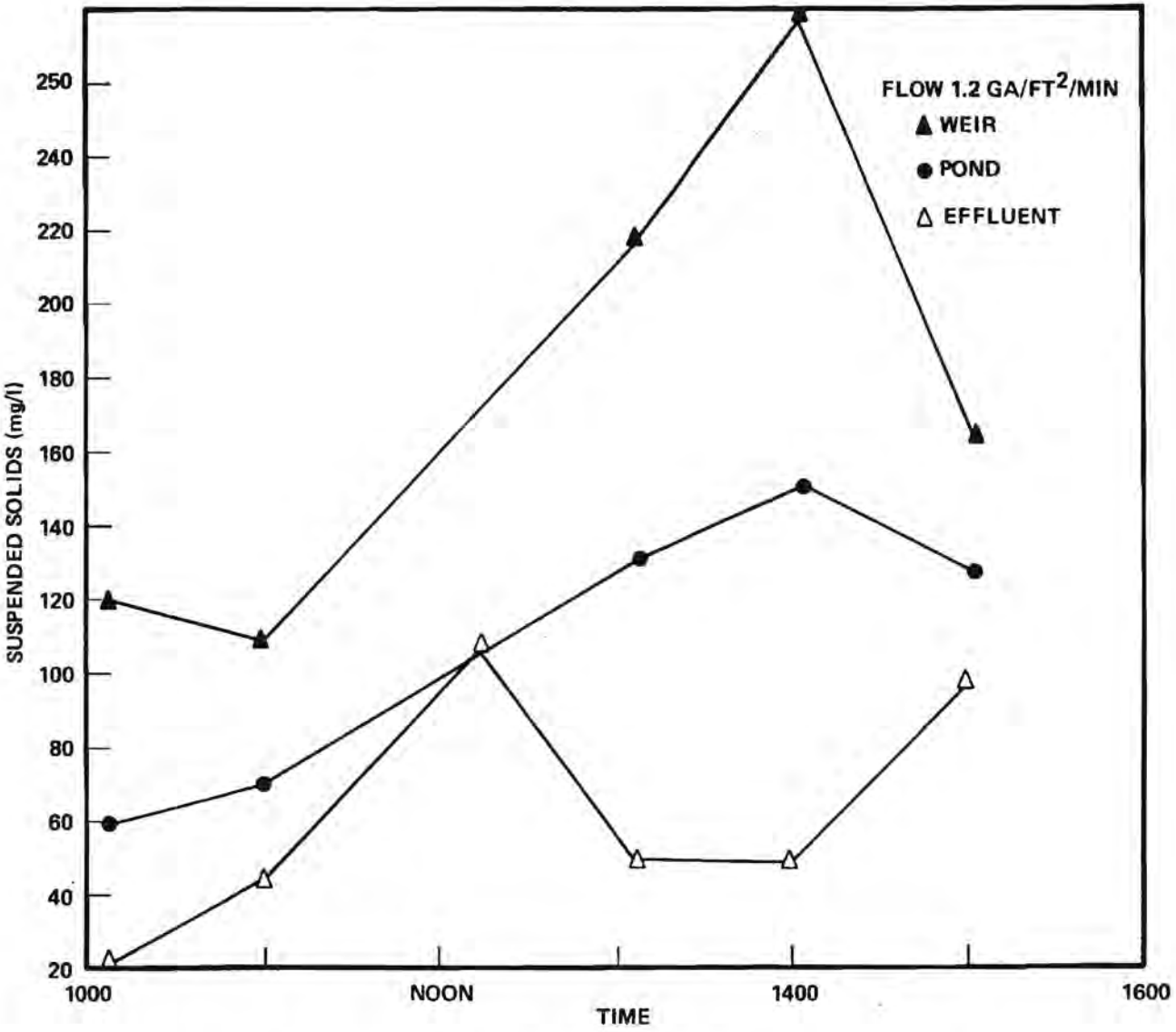


Figure 27. Filtration with Alum and Low Dose of Magnifloc 581C

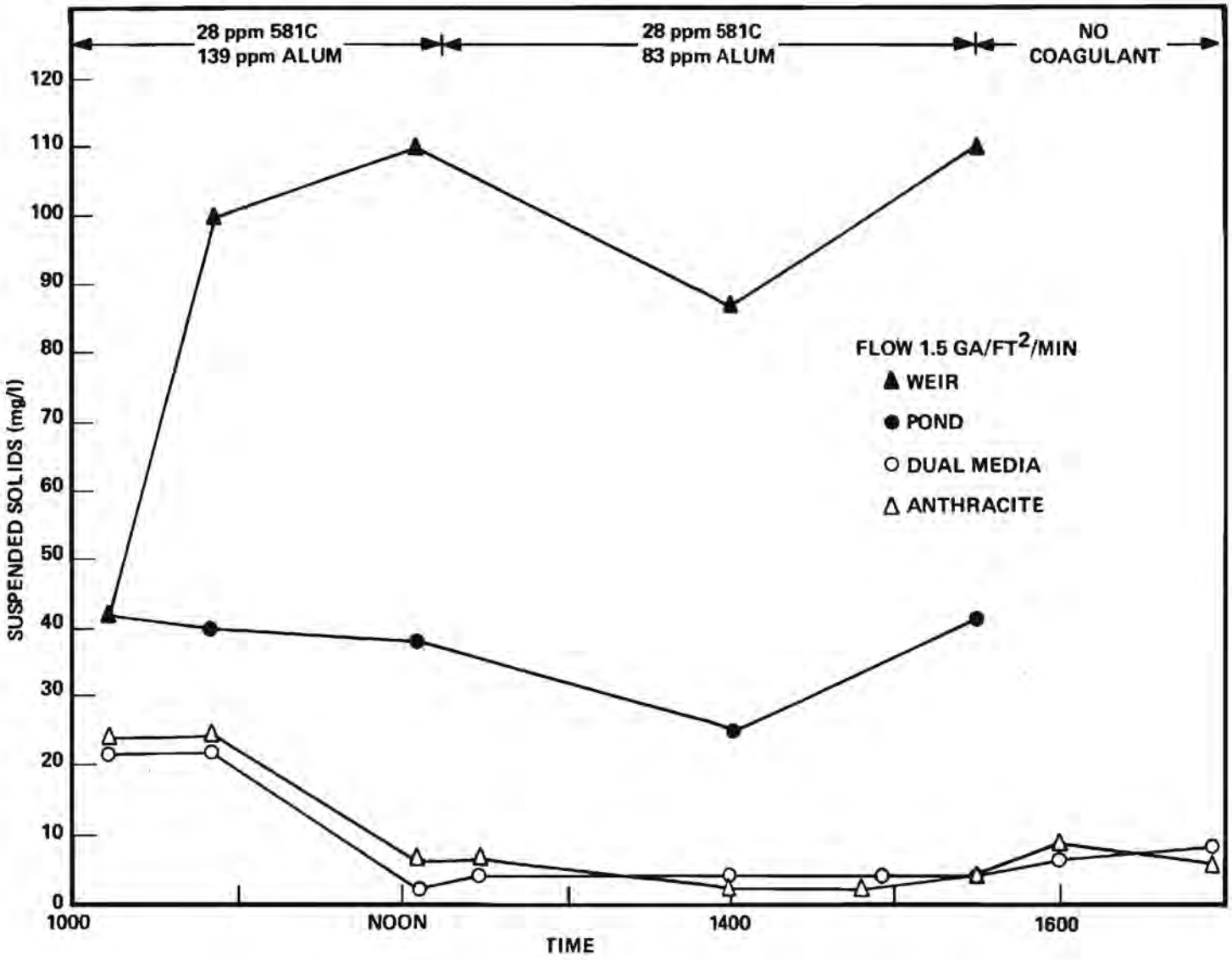


Figure 28. Filtration with High Dose of Alum and Magnifloc 581C

Georgia. In each instance prior to start-up, it was necessary only to get the hoses connected and spread out, the chemical feed system attached, and the inlet pump submerged. Thereafter filtration could begin as soon as power was available. There were recurring problems with the engine which powers the generator due to an intermittent fault in the circuit which activates the starter, and consequently the reliability of the power system was less than desired. A modification of the wiring led to greatly improved conditions. These problems underscore the advantages of operating from a power line where the engine and generator are not needed.

Throughout these studies it has been clear that the length of filter runs is more dependent, for a given set of circumstances, on the total quantity of water filtered than on the rate of filtration. Higher flow rates tend to drive some particulate matter through the filter medium, but the total amount of solids trapped in the filter remains fairly constant. From this it follows that process design which minimizes the delivery of solids to the filter is highly advantageous.

The concept of coagulation followed by a period of sedimentation prior to filtration has much to recommend it. The destabilization of algae by alum or alum-polymer has been shown to be a very simple and straight-forward means for inducing a liquid/solids separation through gravitational sedimentation. In a system designed to preserve a state of quiescence during the settling stage, the outflowing supernatant should contain very little floc or other suspended matter and long filter runs should be routine.

An additional refinement of the process would be to provide a short period of gentle mixing to provide time for full development of the floc and maximum entrapment of suspended matter prior to the period of settling. In this respect, the treatment facility would be quite similar to a water treatment facility in general features, but would be operated to produce acceptable effluent at minimum cost rather than to produce the absolutely highest quality effluent possible.

VIII. Conclusions and Recommendations

The results of this investigation show quite clearly that filtration preceded by flocculant addition is a viable method for reducing the suspended solids concentration in waste stabilization pond effluents. Alum alone may be used, but it appears advantageous to add a small amount of polymer along with the alum, as this produces satisfactory results with an overall reduction in cost of chemicals. The action of a particular polymer cannot be predicted very accurately, and it is believed that in most instances trials will be necessary to evaluate a selected product and to determine the optimum dose rate.

It is concluded that the best arrangement for coagulation/filtration processes would include a period of flocculation and sedimentation following addition of chemicals. In this situation, most of the floc would never reach the filter, and runs of almost any desired length could be obtained. The settled sludge could be returned to the pond, preferably in a widespread manner. The relatively small volume of sludge produced should not interfere with pond operation for a period of at least several years.

Due to the manner in which the experimental filter unit was designed, it was not possible to include a sedimentation step in the field operations. It is now believed that a large additional tank would have provided flexibility to demonstrate other alternate modes of operation. Another possible arrangement could have been a pond system with a small final cell to serve the same purposes, although it is not known if such a facility exists at present.

As a continuation of this investigation it is recommended that a pilot-scale facility including flocculation and sedimentation facilities be installed on a permanent or semi-permanent basis in conjunction with a carefully selected existing facility. The present filter units and backwash tank could be removed from the trailer and positioned on or below grade to provide gravity flow into the filters. The only energy costs would then be those associated with chemical feed and backwashing operations. An operating pilot facility of this nature would demonstrate what could be accomplished in the reduction of suspended solids from waste

stabilization ponds and provide designers with necessary detailed data to design other facilities whose circumstances are similar.

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X. Literature Search

A computerized search of the literature was made for references to subjects concerned with waste stabilization ponds, algae, suspended solids, and filtration. Numerous synonyms were included to insure as thorough search as practical. Two data bases were searched. The first was the Water Resources Abstracts data base which is produced as part of the Water Resources Scientific Information Center (WRSIC) project of the Department of the Interior, Office of Water Research and Technology (OWRT). It is available to Georgia Tech through RECON, a bibliographic retrieval system maintained at the Oak Ridge National Laboratory. The second was Pollution Abstracts, produced by Data Courier, Inc., a data base which collects information concerned with pollution and general environmental quality. It is available through the DIALOG Information Retrieval Service of Lockheed Information Systems, Palo Alto, California.

Several hundred references, the majority of which included abstracts, were obtained. Duplicate and non-relevant citations were removed, and the remainder was listed alphabetically by last name of the author. Anonymous items were included alphabetically by corporate author or source.

The determination of relevance is a somewhat subjective matter, but all items included here were judged to have some bearing on the topic of interest.

Problems encountered in the up-grading of some small sewage works.
Abbott, A. L.; Law, I. B.
Institute of Water Pollution Control: South African 1976 biennial conference Durban, S. Africa June 7-11, 1976
Institute of Water Pollution Control: South African Branch 1976 biennial conference: Papers 77(1), 106-111, Coden: WPOCAH Publ.Yr: 1978
Illus. no refs.
Languages: ENGLISH
Doc Type: CONFERENCE PAPER
Works A, constructed in 1951, consisted of a conventional gravity-fed intake works discharging into a sump whence crude sewage was pumped to 2 primary settling tanks. Upgrading included the provision of additional filter capacity, a 2nd humus tank, rearrangement of recirculation, increasing maturation pond capacity, and installation of gas mixing. Loadings and estimated performance of filters and subsequent units as designed are tabulated. Problems associated with the elevated maturation ponds and acceptance of the effluent by industry have delayed full completion of the scheme. Works B, an activated sludge plant, was designed for an equivalent population of 15,000, with 94% BOD removal. The works consists of intake units, 4 square tanks with surface aerators, a settling tank, sludge beds, and maturation ponds. No nitrification was occurring, and COD removal was only 81%. Modifications to increase aeration are in progress. Works C treats combined domestic and industrial effluents by biological filtration. Extensions to deal with the seasonal peak load from canning operations included increased settling capacity and 4 high-rate filters. Sustained overloads still occurred. Supplementing the filters would be technically effective, but was not economically feasible. Present plans are to submit high-rate filter effluent to secondary roughing filtration before discharge to an aerated lagoon during the canning season. Works D treats sewage from 2 towns with a population of 28,000 persons. By 1964 filtration, humus tank settlement, and digestion were 100% overloaded. Temporary remedial measures, while awaiting inclusion in a regional scheme, were undertaken successfully, including construction of an oxidation pond scheme, alterations to recirculation arrangements, conversion of sand filters to secondary humus tanks, construction of raw sludge dewatering tank, and replacement of mechanical stirring with gas mixing. (FT)
Descriptors: Sewage treatment plants; Pollution control equipment; Engineering
Identifiers: plant upgrading

Treatment capabilities of an extended aeration system following anaerobic lagoons treating meat packing wastes.
ALLEMAN, D.D.
Bell, Balyardt and Wells, Omaha, NE
Proceedings of the Sixth National Symposium on FoodProcessing Wastes. In U.S. Environmental ProtectionAgency. Office of Research and Development. EnvironmentalProtection Technology Series EPA-600/2-76-224, Dec.Dec., 1976. pp. 131-150
Publ.Yr: 1976
Languages: ENGLISH
Descriptors: SUSPENDED SOLIDS; LAGOONS; BOD; AERATION; FOOD PROCESSING INDUSTRY WASTES; ANAEROBIC PROCESS
Identifiers: MEAT PACKING

Algae removal by high gradient magnetic filtration.
Belfort, G.; Yadidia, R.; Abeliovich, A.
Hebrew Univ., Graduate School of Applied Science and Technology, Environmental Health Lab., Jerusalem, Israel.

ENVIRONMENTAL SCIENCE & TECHNOLOGY 11(9), 913-916, Coden: ESTHAG Publ.Yr: Sept. 1977
Illus. refs.
Languages: ENGLISH
A parametric method was used to study the removal efficiency of both laboratory and high-rate oxidation pondgrown Scenedesmus obliquus from dilute solutions by use of high gradient magnetic filtration. The removal was accomplished by coadsorbing the algae and magnetite in the presence of ferric chloride and by placing the mixture for a given residence time in a magnetic filter. Both for the laboratory and pond-grown algae, excellent chlorophyll removals (K90%) were observed for small residence times, low magnetic fields, and reasonable flocculant dosages. (AA)
Descriptors: Algae; Filtration; Adsorption; Water treatment; Lagoons
Identifiers: Scenedesmus obliquus; removal efficiency; high gradient magnetic filtration

Extra-deep ponds.
BEREND,ANDRE
Israel Inst. of Technology, Haifa.
See Cit. No P70-03203.pp 450-456, 1968 Publ.Yr: 1968
Languages: ENGLISH
Descriptors: STABILIZATION PONDS; THERMAL STRATIFICATION; DISSOLVED OXYGEN; ALGAE
Identifiers: EXTRA-DEEP PONDS; ISRAEL; PERFORMANCE

Rapid sand filtration for best practical treatment of domestic wastewater stabilization pond effluent.
BOATRIGHT, D.T.
Univ. of Oklahoma, Health Sciences Center, Dept. of HumanEcology and Environmental Health, Oklahoma City, OK 73140
Journal of Environmental Health, 39(5): 347-352,Mar.-Apr. 1977 Publ.Yr: 1977
Languages: ENGLISH
Descriptors: BOD; WASTEWATER TREATMENT; SUSPENDED SOLIDS; COLIFORMS; LAGOONS; FILTRATION
Identifiers: STABILIZATION POND EFFLUENT; SAND FILTRATION

Performance of high rate shallow stabilization ponds.
BOKIL, S.D.
Indian Inst. of Technology, Dept. of Civil Engineering,Kanpur 208016, India
Indian Journal of Environmental Health, 18(2): 87-98,Apr. 1976 Publ.Yr: 1976
Languages: ENGLISH
Descriptors: SEDIMENTATION; COLIFORMS; BACTERIA; DENITRIFICATION; BOD; WASTEWATER TREATMENT; LAGOONS; ALGAE

Sunnyvale upgrades lagoon effluents.
Chinn, R. B.; Bouey, J. T.
Brown and Caldwell, 1501 N. Broadway, Walnut Creek, CA 94596
WATER AND WASTES ENGINEERING 15(11), 54-62, 95, Coden: WWAEA2 Publ.Yr: Nov. 1978
Illus. no refs.
Sum.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
Innovation, flexibility, and simplicity are features which characterize the new 24-mgd tertiary treatment facility of Sunnyvale, California. The original plant includes raw sewage

screening and pumping, preaeration, primary sedimentation, anaerobic digestion, sludge gas-powered engine-generators with waste heat recovery systems, mechanically aerated oxidation ponds with recirculation pumping, chlorination-dechlorination, and final effluent pumping. In this latest addition, a 450-ft long, parallel 36-in and 48-in diameter siphon conveys pond effluent, waste backwash water, and recycle flows between the ponds and the tertiary plant. The new facilities are designed to reduce ammonia-N and SS levels via a combination of attached growth reactors, dissolved air flotation, and multimedia filtration. Upon completion of startup, Sunnyvale will have one of the most advanced nitrification and algae separation facilities in the U.S. Thus far, plant performance has produced dramatic reductions in ammonia and Cl toxicity, algae discharge, and nutrient levels, and has resulted in unusual enhancement and higher DO levels in the shallow waters of the South San Francisco Bay. (FT)

Descriptors: Wastewater treatment plants; Tertiary treatment ; Engineering; DO; Effluents; Suspended solids; California

Identifiers: Sunnyvale; South San Francisco Bay

Upgrading stabilization pond effluent by water hyacinth culture.

Dinges, R.
Texas Dept. of Health, Wastewater Technology and Surveillance Div., Austin, TX

WATER POLLUTION CONTROL FEDERATION. JOURNAL 50(5), 833-845, Coden: JWPFA5 Publ.Yr: May 1978
Illus. refs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER

A biological system using controlled cultures of water hyacinths, Eichhornia crassipes, was designed to facilitate reduction of algae and N2 content in stabilization pond effluent from 2 wastewater treatment facilities located at the Williamson Creek Wastewater Treatment Plant in Austin, Texas. During the first study period (June 1975-Feb. 1976), there was a mean percent reduction in VSS between influent and effluent of 86%; during the second period (May-Aug. 1976), the mean percent reduction of VSS was 93%. During the first period, chlorophyll a determinations, indicative the quantity of viable algae present in water, were reduced from 0.351 mg/l influent to 0.028 mg/l effluent, a mean percent change of 93%. About 80% of influent K and 50% of P was removed and accumulated by the hyacinths or sediment during the June-Aug. period in the 2 study periods. Significant reduction in BOD5, COD, fecal coliform levels, and total N were also obtained. Mineral nutrients and heavy metals were accumulated by the plants during active growth. The experimental system required minimal attention; temperature was considered the major limitation to the universal use of hyacinths in wastewater treatment. (FT)

Descriptors: Wastewater treatment; Suspended solids; Nitrogen removal; Algae; Biological treatment; Lagoons; BOD; COD; Coliforms; Water demineralization; Aquatic organisms; Heavy metals

Identifiers: Eichhornia crassipes; water hyacinths

Algae production and harvesting from animal wastewaters.

Dodd, J. C.
37, Belmont Ave., Upwey, Victoria 3158, Australia

AGRICULTURAL WASTES 1(1), 23-37, Publ.Yr: Feb. 1979
Illus. refs.
Abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER

The high-rate pond is a type of aerobic waste stabilization pond using shallow depth and intermittent daily mixing to

resuspend settled solids and promote algal growth and photosynthetic oxygenation. The nutrients in the wastewater are converted to algal cells which are harvested to produce a high-protein animal feed comparable with soybean meal. The system is an energy-conserving alternative to conventional treatment processes, e.g., activated sludge or aerated lagoons. While previous systems used sewage as the substrate, use of wastewater from intensive animal production units is also possible. Hydraulic flushing of wastes using recycled effluent is assumed. Due to the high quality of the effluent, makeup water requirements are necessary only to replace evaporation and other losses and prevent long-term build-up of dissolved solids or color constituents which limit algal growth. Primary sedimentation and anaerobic sludge digestion are used to recover energy from the biogas for algae drying and other process energy requirements. Drum drying is preferred. (FT)
Descriptors: Animal feeds; Wastewater treatment; Algae; Energy recovery; Aerobic process; Oxygenation; Photosynthesis; Sludge digestion; Sedimentation
Identifiers: high-rate ponds

Investigation of an anaerobic-aerobic lagoon system treating potato processing wastes.
DORNBUSH, J.N.
South Dakota State Univ., Civil Engineering Dept.,Brookings, SD 57006
Proceedings of the Sixth National Symposium On FoodProcessing Wastes. in U.S. Environmental ProtectionAgency. Office of Research and Development. EnvironmentalProtection Technology Series EPA-600/2-76-224, Dec.Dec. 1976. pp. 3-21
Publ.Yr: 1976
Languages: ENGLISH
Descriptors: ANAEROBIC PROCESS; SUSPENDED SOLIDS; COD; BOD; WASTEWATER TREATMENT; LAGOONS; FOOD PROCESSING INDUSTRY WASTES ; AEROBIC PROCESS
Identifiers: POTATO PROCESSING WASTES

Filtration before recharge.
ANONYMOUS,
UNKNOWN
Effluent and Water Treatment Journal, 10(9) :537, Sept.1970
Publ.Yr: 1970
Languages: ENGLISH
Descriptors: STABILIZATION PONDS; ALGAE; ISRAEL; FILTRATION
Identifiers: RESEARCH STUDIES; ISRAEL INSTITUTE OF TECHNOLOGY

Wastewater treatment ponds: Suspended solids limitations.
EPA
401 M St. SW, Wash., DC 20460
FEDERAL REGISTER 42(195), 54663-54666, Coden: FEREAC
Publ.Yr: Oct. 7, 1977
no refs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
A final rule amending the Secondary Treatment Information regulation to allow less stringent TSS limitations for wastewater treatment ponds is presented. The amendment is based on the fact that properly designed and operated treatment ponds are a form of secondary treatment which may not be capable of achieving the TSS level set forth in the prior regulation. Supplemental treatment processes would have to be employed for removal of TSS, primarily algae. The

amendment adjusts the TSS limitations for wastewater treatment ponds with a maximum facility design capacity of N2 million gpd. The provisions may be considered as guidelines in determining individual NPDES permit requirements for privately and federally owned treatment plants which are not subject to effluent limitation guidelines proposed or promulgated under sections 301, 304, and 306 of the Federal Water Pollution Control Act. Comments from those parties which did not support the rule change are discussed. A suggestion that BOD levels also be adjusted was refused. Suggestions that the TSS limitation be dropped entirely were also rejected. Requests for clarification involved the following: types of wastewater treatment ponds covered, the applicability to new facilities, the applicability to the criteria for best practicable waste treatment technology, and whether specific guidance on implementation of the rule change will be issued. (FT & MS)

Descriptors: Wastewater treatment plants; Wastewater treatment; Water quality acts; Water quality standards; Federal agencies; Federal regulations; Secondary treatment; Suspended solids; Lagoons

Identifiers: EPA; TSS

Removal of algae from waste stabilization pond effluents — a state of the art.

EVANS, RALPH L.1

Illinois State Water Survey, Water Quality Section, Urbana

Illinois. Water Survey. Urbana. Circular No. 108, 12pages, 1972 Publ.Yr: 1972

Languages: ENGLISH

Descriptors: ALGAE; LAGOONS; EFFLUENTS; WASTE WATER TREATMENT

Identifiers: HARVESTING ALGAE; STATE OF THE ART.

Status report on abatement of water pollution from the Canadian pulp and paper industry-1976.

Fisheries and Environment Canada, Environmental Protection Service

CANADA. WATER POLLUTION CONTROL DIRECTORATE. ENVIRONMENTAL PROTECTION SERVICE REPORT SERIES. ECONOMIC AND TECHNICAL REVIEW REPORT EPS 3-WP-77-9 34 pp. Publ.Yr: Sept. 1977

Illus. no refs.

Languages: ENGLISH

Doc Type: REPORT

Progress made to 1976 to regulations to limit the discharge of pollutants in Canadian pulp and paper industry effluents is reported. During the period 1974-76, while pulp and paper production remained essentially steady, TSS were reduced by 6%, BOD by 15%. With all mills in compliance, the discharge of TSS and BOD5 would be 825 and 2,350 TPD, respectively, compared with the 1983 projections (based on 1976 production levels) of 1,060 and 2,870, respectively. Many mills do not yet have toxicity compliance schedules. Some mills have been successfully using internal measures without biotreatment to reduce toxicity, and many are considering following a similar route. Thirteen primary clarifiers and 3 primary settling lagoons were installed in the 2-yr period. The small increase in compliance for SS over the previous 2-yr period can be attributed to the following factors: change to fiber filters tends to increase SS test results where biotreatment is involved; and many clarifiers installed in the period are still in the start-up phase and have not reached optimum removal. Expenditures on abatement facilities for 1974-76 were 1/3 of the total spent for 1960-76, or about $15 million. The newsprint sulfite sector of the industry poses the most difficult problem in the abatement program. At a few sites, consolidation of a number of small mills may be the solution to making liquor recovery more economically attractive. The

high cost ($50,000/T/d) makes the use of thermo-mechanical pulp economically undesirable for mills with existing mechanical pulping facilities. Although mills may use the abatement methods of their choice, the Environmental Protection Service encourages the submission of compliance programs with in-plant controls. Under Federal programs, significant advances have been made in improving abatement technology in the industry. (MS)

Descriptors: Paper industry wastes; Water pollution control; Effluents; Suspended solids; BOD; Toxicity; Government regulations; Canada; Government agencies; Economics; Wastewater treatment

Identifiers: Environmental Protection Service

Filtration of chlorella through dune-sand.

FOLKMAN, YAIR

Isreal Inst. of Technology, Sanitary Engineering Lab.,Haifa, Isreal.

American Society of Civil Engineers. SanitaryEngineering Division. Journal, 96(SA3) :675-690, June1970 Publ.Yr: 1970

Languages: ENGLISH

Descriptors: SEWAGE TREATMENT; ALGAE; FILTRATION; GROUNI WATER RECHARGE; STABILIZATION PONDS

Identifiers: ISRAEL; SAND FILTRATION EXPERIMENTS; CHLORELLA

Storage lagoons come to life.

Frykberg, W. R.; Meier, P. G.; Goodnight, C.

Northeast Michigan Council of Governments, Gaylord, MI 49735

WATER AND WASTES ENGINEERING 15(9), 138-140, Coden: WWAEA2 Publ.Yr: Sept. 1978

Illus. no refs.

Sum.

Languages: ENGLISH

Doc Type: JOURNAL PAPER

The limnology of Michigan storage lagoons which hold water from 3 biological treatment cells before disposal by irrigation was investigated. Over 500 protistan samples were analyzed, identified, and enumerated over a 2-yr study. Green algae dominated the plankton populations of both lagoons during the 1st year of study. Bluegreen algae were never dominant. Greater numbers of diatoms, euglenophytes, and ciliophores were noted during periods of wastewater flow. Wastewater discharge patterns to the lagoon, rather than seasonal factors, affected the dynamics of the ciliophoran populated. Fourteen species of free-living crustaceans and 4 species of rotifers composed the zooplankton community. Zooplankton population was at a minimum during both winters, rose during spring and summer, and peaked in July-Aug. In the lagoon receiving wastewater during the spring and summer, there was a more rapid decline in the population after the summer maxima than in the other lagoon. During periods of ice cover the abundance of zooplankton in the lagoon receiving wastewater was less than that in the other lagoon. Eight species of chironomids accounted for 98.6% of the low density benthic community. Most chemical and physical parameters presented homogeneous distributions with depth. The O2 demanding wastes masked any DO pulses that may have occurred. No seasonal trends were evident in turbidity or secchi disk transparency. Nutrients were not depleted during algal blooms. The heavy metal concentrations, especially of Zn, were high enough to be suspected as responsible for the low concentration of benthic fauna. (FT)

Descriptors: Lagoons; Michigan; Phytoplankton; Zooplankton; Heavy metals; Zinc; Nutrients; Weather

Chlorination seems best for removing suspended solids from lagoon effluents.
HADDOCK, J.K.
Gilbreath, Foster & Brooks, Inc., P.O. Box 2429,Tuscaloosa, AL 35401
Water and Wastes Engineering, 14(5): 48, 50, 52, 54-55,82, May 1977 Publ.Yr: 1977
Languages: ENGLISH
Descriptors: COLIFORMS; NITROGEN; CHLORINATION; PH; BOD; SUSPENDED SOLIDS; LAGOONS
Identifiers: SS REMOVAL

Series intermittent sand filtration to upgrade wastewater lagoon effluent.
Hil, D. W.; Reynolds, J. H.; Harris, S. E.; et al.
Utah State Univ., Utah Water Research Lab., Logan, UT 84321
Eighth international conference on water pollution research Sydney, Australia Oct. 17-22, 1976
Water pollution research: Eighth international conference: Proceedings. In PROGRESS IN WATER TECHNOLOGY 9(4), 799-810, Coden: PGWTA2 Publ.Yr: 1978
illus. refs.
Languages: ENGLISH
Doc Type: CONFERENCE PAPER
A pilot-scale, intermittent sand filtration system was operated at the Logan Municipal Sewage Lagoons in Utah to determine if series operation could increase the length of filter run without a deterioration in effluent quality. Effluent quality was unaffected by series operation; effluent with BOD and SS concentrations J10 mg/l were achieved. With a hydraulic loading rate of 1.5 mgd, filter run lengths 0130 d were obtained. A hydraulic loading rate of 1.5 mgd is recommended with effective sand sizes of 0.17 mm, 0.40 mm, and 0.72 mm placed in 3 separate filters operating in sequence or series. General filter construction should be similar to that employed for waste water lagoon construction. Treatment costs in the U.S. would be about $70/MG. (MS)
Descriptors: Lagoons; Wastewater treatment; Effluents; Filtration
Identifiers: series intermittent sand filtration

Aquaculture as an alternative wastewater treatment system.
JARMAN, R.
Oklahoma State Dept. of Health, OK
Biological Control of Water Pollution. Edited By J.Tourbier and R. W. Pierson, Jr. Philadelphia, Pa.:University of Pennsylvania Press, 1976. pp. 215-224 Publ.Yr: 1976
Languages: ENGLISH
Descriptors: FISH; ALGAE; LAGOONS; SEWAGE TREATMENT; BOD; AQUICULTURE; ECONOMICS; COLIFORMS; WASTE REUSE

Remove algae through microscreening.
Kormanik, R. A.; Cravens, J. B.
Envirex, Inc., P.O. Box 1067 Waukesha, WI 53186
WATER AND WASTES ENGINEERING 15(11), 72-74, Coden: WWAEA2 Publ.Yr: Nov. 1978
illus. no refs.
Sum.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
A test of a full-scale microscreen using 11 polyester media for removal of algae from lagoons is reported. Objectives of the program were to demonstrate that the microscreen can effectively remove algae to meet a 30-30 (BOD-SS) standard, to determine loading rates and headloss requirements, and to

determine the microscreen's cost-effectiveness. All tests demonstrated the screen can consistently remove algae (SS) from a lagoon to 30 mg/L. In general, for each mg/L of SS remaining in the effluent, approximately 1 mg/L of BOD also remains. Hydraulic loading rates varied from 1 to 2.5 gpm/ft2 of submerged media area at 12-in headloss. A headloss of 12 in is required, and a design of 18-in headloss is recommended. Because of operational simplicity, an automated backwash system, and no chemical requirements, this method is very cost-effective compared to other approaches. One important factor in the cost analysis is the ease of disposal of the removed algae. For microscreened algae, the backwash can simply be returned to the head end of the lagoon, causing an insignificant additional load on the system at times. (FT)

Descriptors: Algae; Lagoons; Suspended solids; Straining; Filtration; BOD; Effluents; Algal blooms; Polymers

Identifiers: microscreens

Conception d'etangs anaerobies et facultatifs en milieu nordique. (The idea of anaerobic and facultative ponds in northern environments).

Labonte, R.; Beron, P.

Ecole Polytechnique, C.P. 6079, Succursale "A," Montreal, Que. H3C 3A7, Can.

EAU DU QUEBEC 10(4), 317, 319-322, Coden: EAQUDJ Publ.Yr: Nov. 1977

illus. refs. (All in Eng.)

Languages: French

Doc Type: JOURNAL PAPER

The use of oxidation ponds for wastewater treatment in cold climates must take the local conditions into account. Underlying permafrost may make pond excavation more difficult, and the functioning pond may thaw the permafrost. To avoid the need for excavation, retention dikes may be built on the surface, provided they are strong and impermeable. Anaerobic ponds for primary treatment should be as deep as possible, especially considering that the surface ice in winter may attain a thickness of 1.5 m. There seems to be no point in prolonging the detention time in these ponds beyond 4 d/pond. The discharge pipe must be deep enough that it is not blocked by ice in winter. BOD5 reduction can be 70% in summer and 50% in winter, with a SS reduction of 70% in summer and 80% in winter. Facultative ponds need be only 1.5 m deep in summer, but the winter depth must allow for surface ice. They only function in summer, thus a detention time of 10-12 mo must be allowed. The evacuation system must allow for the varying water depth between summer and winter. The overflow pipe is adjusted to maximum height in winter, then slowly lowered during summer to attain is minimum level just before the onset of freezing weather. Facultative ponds can yield a BOD5 reduction of 80%-90%, with a variable SS removal. Coliforms can be reduced by 99.9% with a sufficiently long detention time. The best treatment is achieved by combining an anaerobic pond for primary treatment with a secondary facultative pond. (FT)

Descriptors: Lagoons; Wastewater treatment; BOD; Suspended solids; Anaerobic systems; Engineering; Primary treatment; Seasonal variations; Freezing

Identifiers: facultative ponds; northern climates

Remove algae and high costs together.

Leininger, K. V.

CH2M Hill, Portland OR

WATER AND WASTES ENGINEERING 14(7), 32-35, Coden: WWAEA2 Publ.Yr: July 1977

illus. refs.

Languages: ENGLISH

Upgrading existing ponds to remove algae is an economical

alternative to replacing them with a treatment plant, according to facilities plans formulated during the past 3 yr. The 2 most reliable algae removal alternatives are chemical treatment, followed by tertiary filtration, and intermittent sand filtration. The latter treatment, however, is labor-intensive because the sand must be frequently cleaned and transported, and the filters are subject to operational problems from freezing in cold weather. Therefore, chemical treatment is felt to be the most economical, reliable, and widely applicable solution available. The cost of this method is estimated to be 20% less than a new plant in capital and operation and maintenance costs. It is important to consider possible requirements for future wastewater treatment plants. The ability of algae to assimilate and concentrate N and P is well known. Removal of algae from pond effluent has the potential for a more economical method of nutrient removal than advanced treatment of conventional secondary plant effluent. In addition, biological nitrification and denitrification often occur during the long residence periods in stabilization ponds. Stabilization pond treatment and algae removal is a rapidly developing, cost-effective technology that will play an expanding role in meeting water quality goals. (from Text)

Descriptors: Algae; Lagoons; Wastewater treatment; Filtration; Economics; Public health; Wastewater treatment plants; Chemical treatment

Wastewater treatment in hot climates.

Mara, D. D.

Univ. of Dundee, Dept. of Civil Engineering, Dundee DD1 4HN, Scot.

Water, wastes and health in hot climates. Edited by R. Feachem; M. McGarry and D. Mara. Wiley-Interscience pp. 264-283 Publ.Yr: 1977

Publ: New York John Wiley & Sons

Illus. refs.

Languages: ENGLISH

The vital aims of waste treatment are destruction of disease causing agents, waste conversion into reusable resources, and water pollution prevention. Particular emphasis in effluent standards should be placed on bacteriological quality, but suspended solids standards are irrelevant in tropical developing countries. If there is sufficient land available, waste stabilization ponds are the preferred method of sewage treatment in hot climates due to the following: low cost; simplicity of operation and maintenance; superior removal of faecal bacteria; and protein production in the form of algae, fish, ducks, and crops. Consideration is also given to aerated lagoons and oxidation ditches. (from Text)

Descriptors: Wastewater treatment; Lagoons; Effluent standards; Engineering; Aerobic systems; Anaerobic systems; Sewage treatment; Organic wastes; Bacteria

Identifiers: hot climates

Two methods for algae removal from oxidation pond effluents.

MARTIN, D.M.

Univ. .of Kansas, Dept. of Civil Engineering, Lawrence,KS 66044

Water & Sewage Works Including Industrial Wastes, 120(3):66-73, Mar. 1973 Publ.Yr: 1973

Languages: ENGLISH

Descriptors: ALGAE; EFFLUENT TREATMENT; FILTERS; FLY ASH; LAGOONS

Identifiers: ALGAE REMOVAL; ROCK FILTER; UPFLOW FLY ASH FILTER

Algal flocculation with aluminum sulfate sulfate and polyelectrolytes.
MCGARRY, MICHAEL G.
Univ. of Western Ontario, London, CAN
Water Pollution Control Federation. Wash., D. C.Journal, 42(5): R191-R201, May 1970 Publ.Yr: 1970
Languages: ENGLISH
Descriptors: OXIDATION PONDS; WASTEWATER TREATMENT; ALGAE; COAGULATION; ALUMINUM COMPOUNDS
Identifiers: POLYELECTROLYTES; ALGAE HARVESTING

Are relaxed lagoon standards too relaxed?
McGimpsey, W. J.
O'Brien, & Gere Engineers, 1304 Buckley Rd., Syracuse, NY 13201
WATER AND WASTES ENGINEERING 15(8), 44-48, Coden: WWAEA2 Publ.Yr: Aug. 1978
Illus. refs.
Sum.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
EPA relaxed effluent solids limits for lagoon type municipal treatment systems N2 mgd because they could not consistently meet the SS requirements. EPA was concerned that any solids separation extension would add to the complexity of the lagoon design and sacrifice the advantages of simplicity, low cost, and minimal energy requirements. The new ceilings are dependent on geographical location. In inclined plate separator tests, however, using 2 mg/L polymer and 1 mg/L copper sulfate, an influent SS level of 40-50 mg/L was reduced to 10-12 mg/L. A full-scale installation incorporating a skimmer would remove 80% of SS. Microstrainer tests gave mixed results, but it controlled chemical feed and better flocculation were provided it's believed microstrainers could be operated successfully. The algal sludge separated by these methods could be returned to the head of the lagoon or disposed of by land application. (FT)
Descriptors: Lagoons; Federal regulations; Effluent standards; Suspended solids; Algae; Technology; Wastewater treatment
Identifiers: inclined plate separators; microstrainers

Algal removal using dissolved air flotation.
MIDDLEBROOKS, E.J.
Ellsworth Engineering & Assoc., Idaho Falls, ID 83401
Water Pollution Control Federation. Journal, 47(1):153-169, Jan. 1975 Publ.Yr: 1975
Languages: ENGLISH
Descriptors: ALGAE; COAGULANTS; FLOCCULATION; FLOTATION; LAGOONS; PILOT PLANTS; SUSPENDED SOLIDS; WASTE WATER TREATMENT
Identifiers: DISSOLVED AIR FLOTATION; PRESSURIZED RECYCLE

Effect of temperature on algal removal from wastewater stabilization ponds by alum coagulation.
MIDDLEBROOKS, E.J.
Mosul Univ., College of Engineering, Mosul, Iraq
Water Research, 9(10): 873-879, Oct. 1975 Publ.Yr: 1975
Languages: ENGLISH
Descriptors: ALGAE; ALGICIDES; ALUMINUM COMPOUNDS; COAGULATION; FLOCCULATION; TEMPERATURE MEASUREMENTS; WASTE WATER TREATMENT
Identifiers: ALGAL REMOVAL; ALUM; STABILIZATION PONDS; TEMPERATURE VARIATIONS

Intermittent sand filtration for upgrading waste stabilization pond effluents.
MIDDLEBROOKS, E.J.
Utah State Univ. of Agriculture and Applied Science,College of Engineering, Utah Water Research Lab., Logan,UT 84321
Water Pollution Control Federation. Journal, 49(1):83-102, Jan. 1977 Publ.Yr: 1977
Languages: ENGLISH
Descriptors: COD; FILTRATION; WASTEWATER TREATMENT; TEMPERATURE; DO; BOD; SUSPENDED SOLIDS; EFFLUENT TREATMENT; HYDRAULICS; LAGOONS; AMMONIA; PHOSPHORUS; PH
Identifiers: SAND FILTRATION

Effects of high organic loading on mixed photosynthetic wastewater treatment.
MILLER, S.
Univ. of Cape Town, Dept. of Chemical Engineering, P.O.Box 594, Cape Town, S. Africa
Water Pollution Control Federation. Journal, 49(3): Pt.1: 436-440, Mar. 1977 Publ.Yr: 1977
Languages: ENGLISH
Descriptors: WASTEWATER TREATMENT; LABORATORY METHODS; PHOTOSYNTHESIS; ALGAE; PH; LAGOONS; BIODEGRADATION; SLUDGES; GROWTH
Identifiers: HIGH ORGANIC LOADING

Fish polyculture in sewage effluent ponds.
Muthuswamy, S.; Basha, C. J.; Govindan, V. S.; et al.
College of Engineering, Public Health Engineering Dept., Guindy, Madras, 600 025, India
INDIAN JOURNAL OF ENVIRONMENTAL HEALTH 20(3), 219-231, Coden: IJEHBP Publ.Yr: July 1978
illus. refs.
Abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
Three oxidation ponds inside the sewage treatment demonstration plant at the College of Engineering in Guindy were connected in series to treat and utilize 180,000 L/d of sewage. The algae used in sewage treatment were utilized to sustain fish inhabiting different strata of the water column. In Pond-III, DO was 2.0-4.5 mg/L, maximum BOD reduction was about 96%, coliform removal was 99.99%, and P and N nutrients were high enough to support good algal growth. The height and length of Labeo fimbriatus and Labeo rohita were higher in the 3rd pond than in the 2nd. Cirrhina mrigala growth was similar in both ponds at 83 d; after 90 d, the growth rate in the 2nd pond was higher than in the 3rd. Cyprinus carpio had a remarkable growth rate (1020 g at 206 d). Fish production in the 2nd and 3rd ponds was computed as 11545 kg/ha/yr. (AM, SS)
Descriptors: Fish; Lagoons; Sewage treatment plants; Algae; BOD; DO; Coliforms
Identifiers: Cyprinus carpio; Cirrhina mrigala; Labeo rohita ; Labeo fimbriatus

Upflow filtration improves oxidation pond effluent.
PATTERSON, R.K.
Univ. of Nebraska, Lincoln, NE 68503
Water & Sewage Works Including Industrial Wastes, 121(7):82-33, July 1973 Publ.Yr: 1973
Languages: ENGLISH
Descriptors: BOD; COD; FILTRATION; LAGOONS; NEBRASKA; SEWAGE TREATMENT; SUSPENDED SOLIDS; WASTE WATER TREATMENT
Identifiers: HALLAM; UPFLOW FILTRATION

Electrolytic control of algae.
PAUL, S.K.
Calcutta Metropolitan Development Authority, Calcutta,India
American Water Works Association. Journal, 67(3):140-141, Mar. 1975 Publ.Yr: 1975
Languages: ENGLISH
Descriptors: ALGAE; EFFLUENT TREATMENT; ELECTROCHEMISTRY; LAGOONS; WATER QUALITY CONTROL; WATER TREATMENT PLANTS
Identifiers: ALGAL CONTROL; ELECTROLYTIC CONTROL

Algae separation from oxidation pond effluents.
PEAKS, D.A.
Tennessee Technological Univ., Cookeville, TN 38501
Purdue Industrial Waste Conference: 30th Annual:Abstracts of scheduled presentations. (n.p.), (1975?).p. 4 Publ.Yr: 1975
Languages: ENGLISH
Descriptors: ALGAE; COAGULATION; EFFLUENTS; LAGOONS
Identifiers: ABSTRACT ONLY; ALGAE SEPARATION

Algae separation from oxidation pond effluents.
PEAKS, D.A.
Tennessee Technological Univ., Dept. of Civil Engineering,Cookeville, TN 38501
Water Pollution Control Federation. Journal, 49(1):111-119, Jan. 1977 Publ.Yr: 1977
Languages: ENGLISH
Descriptors: COD; EFFLUENTS; PH; FLOTATION; SEDIMENTATION; COAGULANTS; WASTEWATER TREATMENT; LAGOONS; ALGAE
Identifiers: ALGAE SEPARATION; WATER CLARITY

Les possibilites offertes par les tambours de microfiltration dans le traitement des eaux usees. The possible applications of micro-screening drums in waste water treatment.
Perrier, A.
Materiel Perrier
TECHNIQUES ET SCIENCES MUNCIPALES ET REVUE L'EAU 78(10), 521-523, Coden: TSCMA9 Publ.Yr: Oct. 1978
illus. • no refs.
Eng., Fr. sums.
Languages: French
Doc Type: JOURNAL PAPER
The use of microscreening drums in treating wastewaters (especially urban effluents) after biological purification reduced residual pollution by 50%. The lower costs involved in this technique would optimize the efficiency:cost ratio of a purification process. (MS)
Descriptors: Wastewater treatment; Effluent treatment; Municipal wastewaters; Straining; Pollutant removal; Pollution control equipment; Water purification; Filtration; Filter media
Identifiers: microscreening drums

Update on status of intermittent sand filtration to upgrade lagoon effluents.
REYNOLDS, J.H.
Utah State Univ. of Agriculture and Applied Science, Div.Of Environmental Engineering, Logan, UT 84321
National Conference on Environmental EngineeringResearch, Development and Design: Second Annual: ExtendedAbstracts. (n.p.), (1975?). 3 pp Publ.Yr: 1975
Languages: ENGLISH
Descriptors: ECONOMICS; EFFLUENTS; FILTRATION; LAGOONS;

Removal of suspended and colloidal solids from waste streams by the use of cross-flow microfiltration.
Sundaram, T. R.; Santo, J. E.
Hydronautics Inc., Applied Science Dept., Laurel, MD 20810
American Society of Mechanical Engineers, Aerospace Division: Intersociety Conference on Environmental Systems. San Francisco, Calif. July 11-14, 1977
In AMERICAN SOCIETY OF MECHANICAL ENGINEERS. PAPER 77-ENAs-51 12 pp Publ.Yr: (1977?)
Illus. refs.
Languages: ENGLISH
Doc Type: CONFERENCE PAPER
Results are presented from laboratory tests on the microfiltration of waste effluents utilizing unique, thick-walled tubular microfilters. These microfilters which can be made from many common thermoplastics (such as polyethylene and nylon), enable the almost total removal of SS even at very low (j5 psi) filtration pressures. The unique feature of the tubes is that their pore sructure can be controlled during the production process. Optimum filtration performance can be obtained for different waste effluents by using tubes of different pore structures. This unique ability for tubes to be "tailored" to the characteristics of a given effluent under consideration, assures that success can be achieved with most effluents through a series of systematic, laboratory "screening" tests. Results are presented for tests on oil-water emulsions, laundry wastes, sewage wastes, turbid water, and food processing wastes. Relatively high filtrate-flux levels can be maintained even after hundreds of hours of operation. In addition to the nearly total removal of SS, the tubes yield significant reductions in COD and BOD. (AM)
Descriptors: Filtration; Wastewater treatment; Suspended solids; Colloids

Algal-photosynthesis and algal-bacterial symbiosis in high-rate aerobic oxidation ponds.
Tamam, G. A.; Ganapati, S. V.
Synbiotics Ltd., Spore Lab., Baroda, India
ASIAN ENVIRONMENT 1(1), 15-21, Publ.Yr: 1978
Illus. refs.
No abs.
Languages: ENGLISH
Doc Type: JOURNAL PAPER
Flasks containing 1,450 ml of fresh, raw, settled homogeneous sewage were inoculated with 50 ml of a 10% culture of the algae Scenedesmus obliquus or Microcystis aeruginosa; other flasks were filled with 1,500 ml of sewage only. In the control flasks, ammonia-N (NH3-N) fell by 80.6% in 1 case and 20% in another after 6 d, compared to drops of 65.4% (M. aeruginosa) and 84.6% (S. obliquus) after 2 d and 86.6% and 90.0% after 6 d in the inoculated flasks. There was no appreciable change in phosphate concentration in the control, compared to 42.9%-67.2% reduction in 2 d and 61.1%-83.2% reduction in 6 d with algae. Control flask BOD reduction was 50%-70.4% in 6 d; algae flasks had 42.9%-67.2% reduction in 2 d and 61.1%-83.2% in 6 d. COD was reduced 53.6%-64.5% in the controls within 6 d, but 68.5%-74.2% in 2 d and 84.9%-90.8% in 6 d with algae. Algal dry weights in the flasks reached 224-275 mg/l on the 2nd d, but only 236-282 mg/l by the 6th d. COD and BOD reduction in the controls is attributable to mechanical flocculation, bioflocculation, and bioprecipitation. Greater reduction in the algae flasks is to be ascribed to photosynthetic O2 furnished to bacteria by algae respiration. Calculations indicate that the bacterial growth rate increases with the detention period. Photosynthetic O2 production is 9%-18% greater than bacterial O2 demand, so the ecosystem is always maintained under aerobic conditions. (FT)
Descriptors: Algae; Bacteria; Lagoons; Aerobic systems; Sewage treatment; Nitrogen removal; BOD; COD; Photosynthesis

Modifications for upgrading existing lagoons.
TATMAN, D.R.
Edward H. Richardson Assoc., Dover, DE 19901
National Conference on Environmental EngineeringResearch, Development and Design: Second Annual: ExtendedAbstracts. (n.p.), (1975?). 1 p Publ.Yr: 1975
Languages: ENGLISH
Descriptors: AERATION; ALGAE; BOD; FILTRATION; FLOTATION; LAGOONS; PHOSPHORUS
Identifiers: ABSTRACT ONLY; UPGRADING METHODS

Aerofac aerated lagoons.
TIKHE, M.L.
Malaviya Regional Engineering College, Jaipur, Rajasthan,India
Water Pollution Control Federation. Journal, 47(3)Pt. 1:626-629, Mar. 1975 Publ.Yr: 1975
Languages: ENGLISH
Descriptors: AERATION; AEROBIC PROCESS; BOD; INDUSTRIAL EFFLUENTS; LAGOONS; MATHEMATICAL ANALYSIS; MUNICIPAL WASTE WATERS; SUSPENDED SOLIDS
Identifiers: DETENTION TIME; FACULTATIVE LAGOON

Water reclaimation and algae harvesting.
TONGKASAME, C.
Asian Inst. of Technology, Dept. of EnvironmentalEngineering, Bangkok, Thailand.
Water Pollution Control Federation. Wash., D.C.Journal, 43(5): 824-835, May 1971 Publ.Yr: 1971
Languages: ENGLISH
Descriptors: WATER RECLAMATION; ALGAE; THAILAND; OXIDATION PONDS; WASTEWATER TREATMENT
Identifiers: ALGAE HARVESTING

Sewage treatment by means of oxidation ponds.
VALDEZ-ZAMUDIO, F.
Ministerio de Pesqueria, Cientifica y Technologica,Lima, Peru
Science of the Total Environment, 2(4): 406-409, July1974 Publ.Yr: 1974
Languages: ENGLISH
Descriptors: ALGAE; BACTERIA; LAGOONS; OXIDATION; PERU; SEWAGE TREATMENT
Identifiers: LIMA

Removal of algae from stabilization pond effluents by lime treatment.
WACHS, A.M.
Tahal Water Planning Ltd., Dan Region Sewage ReclamationProject, Israel
Water Research, 7(3): 18 pp., Mar. 1973 Publ.Yr: 1973
Languages: ENGLISH
Descriptors: ALGAE; FLOCCULATION; LAGOONS; LIME; NUTRIENTS; SEWAGE TREATMENT
Identifiers: ALGAL REMOVAL

Light intensity and the vertical distribution of algae in tertiary oxidation ponds.
WEISS, CHARLES M.
Univ. of North Carolina, School of Public Health, Dept.of Environmental Sciences and Engineering, Chapel Hill
Water Research. New York, 4(11): 751-763, Nov. 1970 Publ.Yr: 1970
Languages: ENGLISH
Descriptors: WASTEWATER TREATMENT; OXIDATION PONDS; ALGAE; LIGHT INTENSITY

Removal of algae from lagoon effluents with submerged rock filters.
WELLER, R.
Univ. of Kansas, Lawrence, KS 66044
National Conference On Environmental EngineeringResearch, Development and Design: Second Annual: ExtendedAbstracts. (n.p.), (1975?). 2 pp Publ.Yr: 1975
Languages: ENGLISH
Descriptors: ALGAE; BOD; EFFLUENTS; FILTERS; LAGOONS; SUSPENDED SOLIDS
Identifiers: ABSTRACT ONLY; ALGAE REMOVAL; SUBMERGED ROCK FILTERS

How to design aerated lagoon systems to meet 1977 effluent standards: Experimental studies.
WHITE, S.C.
South Carolina Dept. of Health and Environmental Control,2600 Bull St., Columbia, SC 29201
Water & Sewage Works, 123(3): 85-87, Mar. 1976 Publ.Yr: 1976
Languages: ENGLISH
Descriptors: AERATION; BOD; EFFLUENT STANDARDS; LAGOONS; SEWAGE TREATMENT; SOUTH CAROLINA; SUSPENDED SOLIDS
Identifiers: AERATED LAGOON SYSTEMS

Properties and products of algae.
ZAJIC, J. E.
Univ. of Western Ontario, Faculty of Engineering Science,London, Can.
Properties and Products of Algae, Symposium.Proceedings. (Held in New York City, Sept. 7-12, 1969.) Sponsored by American Chemical Society, Division ofMicrobial Chemistry and Technology, New York. PlenumPress, New York, 154 pages. 1970 Publ.Yr: 1970
Languages: ENGLISH
Descriptors: ALGAE; FOOD CROPS; STABILIZATION PONDS; EUTROPHICATION

AERATED STABILIZATION OF BOARD MILL WHITE PAPER.
AMBERG, HERMAN R.
CROWN ZELLERBACH CORP., CAMAS, WASH.
PROCEEDINGS, INDUSTRIAL WASTE CONFERENCE, 21ST, MAY 3, 4, 5, 1966. PURDUE UNIVERSITY, VOL 1, NO 2, P 525-537, MARCH 1966. 4 FIG, 9 TAB, 6 REF.
*AERATED STABILIZATION, SUSPENDED SOLIDS.
05D
A SURVEY OF THE RESULTS AND COMPARISON OF THE PRESENT OPERATIONAL EFFICIENCY OF THE AERATED STABILIZATION LAGOON WITH THE EFFICIENCY OF THE ORIGINAL STABILIZATION POND IS PRESENTED. IT WAS FOUND THAT BY ADDING AERATORS TO THE STABILIZATION PONDS AN AVERAGE OF 81% OF THE BOD WAS REMOVED, A SUSPENDED SOLIDS REDUCTION OF APPROXIMATELY 91%, AND A BIOLOGICAL SLUDGE PRODUCTION OF ABOUT 4.5 LBS/LB OF BOD REMOVED. THE AERATION BASIN, OPERATED AS A COMPLETELY MIXED SYSTEM, WAS EXTREMELY EFFECTIVE IN HANDLING WIDE FLUCTUATIONS IN DAILY BOD LOAD. OPERATING COSTS FOR THE BALTIMORE TREATMENT PLANT HAVE BEEN CALCULATED AT $0.72/TON OF PRODUCTION OR $0.0162/LB OF BOD REMOVAL. (ELLIS-TEXAS)

LAGOONS GET SECONDARY TREATMENT OK
THE AMERICAN CITY AND COUNTY, VOL. 92, NO. 12, P 41-42, DECEMBER, 1977. 1 FIG, 1 TAB.
FIELD 05D
THE TWO MAIN PROBLEMS ENCOUNTERED IN OPERATING WASTE WATER TREATMENT LAGOONS ARE SHORT-CIRCUITING AND HYDRAULIC OR ORGANIC OVERLOADING. INSUFFICIENT SUNLIGHT WILL KILL THE OXYGEN-PRODUCING ALGAE, THUS LIMITING THE GROWTH OF AERODIC BACTERIA THAT DEGRADE THE ORGANIC WASTES. THE LOWER PART OF THE PONDS SHOULD BE SEALED TO PREVENT WATER FROM LEAKING OUT THROUGH THE SURROUNDING SOIL. COVERING THE EARTH BERMS AROUND THE LAGOONS WITH ASPHALT IS THE PREFERRED METHOD OF PREVENTING EROSION; VEGETATION IS USUALLY UNSUITABLE. THE PIPING SYSTEM SHOULD ALLOW THE OPERATOR TO CONTROL FLOW AND DEPTH IN EACH POND. SUCH A SYSTEM MAKES IT POSSIBLE TO REST AN OVERLOADED POND, SWITCH BETWEEN PARALLEL AND SERIES OPERATION, RECIRCULATE PART OF THE EFFLUENT, CONTROL WEEDS, AND RETAIN ALL EFFLUENT DURING THE WINTER.

BIOCHEMICAL CHANGES IN OXIDATION PONDS.
AMIN, P. M.; GANAPATI, S. V.
MAHARAJA SAYAJIRAO UNIV. OF BARODA (INDIA). DEPT. OF BIOCHEMISTRY.
JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 44, NO 2, FEBRUARY 1972, P 183-200, 11 FIG, 5 TAB, 68 REF.
05D;05G
A LABORATORY STUDY OF THE FIRST OPERATIONAL STAGE OF A WASTEWATER LAGOON, NAMELY, THE 28 DAY PERIOD OF NON-CHANGING ENVIRONMENT WHEN ALGAE ARE ALLOWED TO DEVELOP NATURALLY, SHOWED THAT THIS STAGE IS SEPARATED INTO TWO DISTINCT PHASES, THE BACTERIAL PHASE I AND THE ALGAL PHASE II. THE MOST NOTABLE FINDINGS WERE: (1) ABSENCE OF ACIDITY IN BOTH PHASES; (2) ABSENCE OF DISSOLVED OXYGEN IN PHASE I AND ITS ABUNDANCE IN PHASE II; (3) LARGE REDUCTIONS IN COLIFORM DENSITY; (4) LARGE INCREASES AND DECREASES IN BIOCHEMICAL CONSTITUENTS, SUCH AS SUGARS, IN PHASE I AND PHASE II, RESPECTIVELY; (5) INCREASES IN FATTY SUBSTANCES AND CHLOROPHYLLS; (6) LARGE PROTOZOA POPULATION IN PHASE I COMPARED TO LARGE ALGAL POPULATIONS IN PHASE II; AND (7) LACK OF APPRECIABLE SLUDGE FORMATION. CARBOHYDRATE USAGE MOSTLY FOR SYNTHESIS OF FATTY SUBSTANCES AND MUCH LESS FOR POLYMER ACCUMULATIONS WITHIN CELLS, RESULTED IN MORE FAT IN THE CLEAR FINAL EFFLUENT, THUS EXPLAINING THE ABSENCE OF SLUDGE IN THE ECOSYSTEM. (LOWRY-TEXAS)

EFFECTS OF DEPTH OF WASTE STABILIZATION POND PERFORMANCE.
ANDERSON, S. K.
VIRGINIA POLYTECHNIC INST., BLACKSBURG.
MASTER'S THESIS, 1969, 75 P, 17 FIG, 4 TAB, 37 REF.
*SUSPENDED SOLIDS, CHASE CITY(VA).
05D
AN 8 ACRE POND WITH A 3 FT DEPTH AND A 4 ACRE POND WITH A 6 FT DEPTH WERE BOTH LOADED AT 26 LB BOD/ACRE/DAY. BOTH PONDS HAD BEEN OPERATING FOR TWO YEARS ON DOMESTIC WASTES. FOLLOWING A 45 DAY ACCLIMATION PERIOD, DISSOLVED OXYGEN, TEMPERATURE, AND PH MEASUREMENTS WERE TAKEN DURING 24 HOUR TESTING PERIODS SPACED AT 2 WEEK INTERVALS FOR A 12 WEEK PERIOD. BOD AND SUSPENDED SOLIDS CONCENTRATIONS WERE ALSO MEASURED DURING EACH TESTING PERIOD. ALL POND LEVELS CONTAINED DISSOLVED OXYGEN AT ALL TIMES, WITH THE DEEPER LEVELS SOMETIMES APPROACHING THE ANAERODIC STATE. MEANWHILE, ALGAL PHOTOSYNTHESIS PRODUCED LEVELS OF 20 MG/1 DISSOLVED OXYGEN IN THE UPPER LEVELS OF THE POND, WHILE RAISING TO PH ABOVE 10. BECAUSE OF THE FREQUENT D.O. INTRUSIONS TO THE BOTTOM LEVEL, METHANE FERMENTATION WAS NEVER ESTABLISHED. THE 6 FT POND DEPTH IN THE DEEPER POND WAS SUFFICIENT TO INSURE THE

ESTABLISHMENT OF A DEFINITE THERMOCLINE UNDER EXISTING CLIMATIC CONDITIONS IN VIRGINIA. BOTH THE BOD AND THE SUSPENDED SOLIDS IN THE EFFLUENT PRESENT AT CONCENTRATIONS OF 30-40 PPM AND 350 PPM RESPECTIVELY, WERE ATTRIBUTED TO ALGAE CARRIED OVER IN THE EFFLUENT. IN ACCORDANCE WITH OTHER RECENT STUDIES AND WITH THEORY, IT WAS DEMONSTRATED THAT THE DEEPER POND CONSISTENTLY PRODUCED A SUPERIOR EFFLUENT IN TERMS OF BOTH BOD AND SS. (LOWRY-TEXAS)

ENGINEERING ASPECTS OF WASTE WATER TREATMENT IN AERATED RING-SHAPED CHANNELS.
ARGAMAN, Y.; SPIVAK, E.
TECHNION - ISRAEL INST. OF TECH., HAIFA.
WATER RESEARCH, VOL 8, NO 5, P 317-322, MAY, 1974. 4 FIG, 2 TAB, 5 REF.
05D;08A
RING-SHAPED AERATED CHANNELS MAY BE USED FOR WASTE WATER TREATMENT AS OXIDATION DITCHES, AERATED LAGOONS, OR HIGH-RATE PONDS. THE AERATORS UTILIZED IN THESE SYSTEMS PROVIDE THE NECESSARY OXYGEN AND GENERATE A FLOW VELOCITY THAT WILL KEEP PARTICULATE MATTER IN SUSPENSION. WHEN MECHANICAL SURFACE AERATORS ARE USED, THE FLOW VELOCITY AND THE OXYGEN SUPPLY RATE DEPEND ON THE CHANNEL GEOMETRY AND THE AERATOR ROTATION SPEED AND SUBMERGENCE. A DESIGN PROCEDURE THAT WILL SIMULTANEOUSLY SATISFY OXYGEN AND FLOW REQUIREMENTS IS PRESENTED. IT INVOLVES PROCESS KINETICS, OPEN-CHANNEL FLOW HYDRAULICS, AND AERATOR PERFORMANCE ASPECTS. EXPERIMENTS IN A PILOT AERATION CHANNEL, OPERATED AS A HIGH-RATE POND, INDICATE THAT THE MINIMUM FLOW VELOCITY FOR SUCH SYSTEMS IS BETWEEN 3.5 AND 6.5 CM/SEC WHEN THE SUSPENDED SOLIDS CONCENTRATION IS ABOUT 500 MG/LITER. THE PUMPING EFFICIENCY OF A 70 CM WIDE CAGE ROTOR AERATOR WAS ABOUT 4% WHEN THE SUBMERGENCE DEPTH WAS 12-17 CM. CALCULATIONS SHOW THAT ATMOSPHERIC REAERATION, INDUCED BY HIGH FLOW VELOCITY, IS NOT ECONOMICAL. ON THE OTHER HAND, A COMBINATION OF A PUMP AND AN AERATOR MAY PROVE FEASIBLE IN CASES WHERE FLOW VELOCITY RATHER THAN OXYGEN SUPPLY IS THE LIMITING FACTOR. (WITT-IPC)

TREATMENT OF POTATO PROCESSING WASTES AT SALADA FOODS LTD., ALLISTON.
ARMSTRONG, T. D.; BOYKO, B. I.
ONTARIO WATER RESOURCES COMMISSION, TORONTO.
PROCEEDINGS, ONTARIO INDUSTRIAL WASTE CONFERENCE, 16TH, JUNE 1969, NIAGARA FALLS, ONTARIO, P 188-208.
*POTATO PROCESSING WASTES, AEROBIC LAGOONS, ANAEROBIC LAGOONS.
05D
THE SALADA PLANT AT ALLISTON, ONTARIO, WAS CONSTRUCTED IN 1959. AT THIS TIME, 5000 LBS/HR OF POTATOES WERE PROCESSED INTO POTATO FLAKES DURING A 24 HOUR DAY. SINCE THAT TIME NEW PRODUCTS HAVE BEEN ADDED, AND WATER CONSUMPTION, INITIALLY 200,000 GPD NOW RANGES FROM 630,000 TO 750,000 GPD DURING THE AUGUST TO MAY PROCESSING SEASON. THE COMPANY AND THE TOWN WERE TO CONSTRUCT SECONDARY TREATMENT FACILITIES JOINTLY. THE INITIAL INSTALLATION WAS DESIGNED FOR A WASTE FLOW OF 150,000 GPD AND INCLUDED SCREENING, SEDIMENTATION, AN ANAEROBIC LAGOON, AND TWO AEROBIC LAGOONS. THE LAGOON FILLED FOR 5 1/2 MONTHS, AND EFFLUENT ON THE FIRST DAY OF OVERFLOW WAS 376,000 GALLONS WITH CORRESPONDING 6010 LBS BOD. THE PLANT WAS OVERLOADED BOTH HYDRAULICALLY AND ORGANICALLY. THE ANAEROBIC LAGOON WAS CHANGED TO AN AEROBIC LAGOON. TWO CONCRETE CLARIFIERS WERE ADDED, EACH WITH 2.75 HOURS DETENTION TIME, AND BUBBLE GUN AERATION DEVICES WERE INSTALLED. SINCE THE PLANT WAS STILL OVER-LOADED, A COMPREHENSIVE SURVEY WAS ORDERED, AND FROM THE RESULTS OF THIS STUDY, A 6.2 HOUR DETENTION TIME ACTIVATED SLUDGE BASIN WAS BUILT. TOTAL COST OF THE TREATMENT PLANT HAD RISEN TO $350,000. ALTHOUGH PROBLEMS WERE STILL ENCOUNTERED, THIS TREATMENT FACILITY PROVIDED ADEQUATE TREATMENT. HAD THE NECESSARY LONG RANGE PLANNING BEEN DONE EARLIER, A SERIOUS POLLUTIONAL PROBLEM MAY HAVE BEEN AVOIDED. (LOWRY-TEXAS)

ALGAL NUTRIENT RESPONSES IN AGRICULTURAL WASTE WATER.
ARTHUR, JAMES F.; BROWN, RANDALL L.; BUTTERFIELD, BRUCE A.; GOLDMAN, JOEL C.
FEDERAL WATER QUALITY ADMINISTRATION, FRESNO, CALIF.; AND CALIFORNIA STATE DEPT. OF WATER RESOURCES.
IN: COLLECTED PAPERS REGARDING NITRATES IN AGRICULTURAL WASTE WATERS, FEDERAL WATER QUALITY ADMINISTRATION WATER POLLUTION CONTROL RESEARCH SERIES 13030 ELY, 12/69, P 123-141, DECEMBER 1969. 19 P, 8 FIG, 1 TAB, 12 REF. FWQA PROJECT 13030 ELY.
*CENTRAL VALLEY(CALIFORNIA), *BACTERIAL DENITRIFICATION.
05D;05B
ALGAL ASSIMILATION OF NUTRIENTS INTO CELLULAR MATERIAL WITH SUBSEQUENT REMOVAL FROM THE GROWTH MEDIUM IS A FEASIBLE PROCESS TO REMOVE NITRATES FROM IRRIGATION WASTE WATER. THE EFFICIENCY OF THE PROPOSED SYSTEM IS GREATLY ENHANCED IF AS MANY VARIABLES AS POSSIBLE ARE OPTIMIZED, LEAVING ONLY NITROGEN THE LIMITING NUTRIENT. ORTHOPHOSPHATE ADDITIONS OF 2.0-3.0 MG/LITER P ARE REQUIRED THE YEAR ROUND TO REMOVE 20.0 MG/LITER NITRATE-NITROGEN FROM THE GROWTH MEDIUM. IRON AND CARBON ALSO HAVE BEEN FOUND TO BE LIMITING ALGAL GROWTH AND NITROGEN ASSIMILATION DURING PART OF THE YEAR.

EFFECTS OF OXIDATION POND EFFLUENT ON RECEIVING WATER IN THE SAN JOAQUIN RIVER ESTUARY.
BAIN, RICHARD C., JR.; MCCARTY, PERRY L.; ROBERTSON, JAMES A.; PIERCE, WILLIAM H.
FEDERAL WATER QUALITY ADMINISTRATION, PACIFIC SOUTHWEST REGION, CALIFORNIA/NEVADA BASINS OFFICE.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 168-180. 8 FIG, 6 TAB, 8 REF.
*SAN JOAQUIN RIVER.
05D;05C
OXIDATION POND EFFLUENT ENTERING THE SAN JOAQUIN RIVER ESTUARY WAS ASSUMED TO BE A MAJOR CAUSE OF LOW DISSOLVED OXYGEN LEVELS, AND RESULTANT FISH KILLS. IN AN EFFORT TO PROVE OR DISPROVE THIS ASSUMPTION, FACTORS CONSIDERED RELATED TO DISSOLVED OXYGEN CONCENTRATION WERE STUDIED. THESE FACTORS INCLUDED WATER TEMPERATURE, ALGAL POPULATION, OXYGEN DEMANDS, NUTRIENTS, AND CHANNEL AND FLOW CHARACTERISTICS. SAMPLES WERE TAKEN FROM THE RIVER AT VARIOUS TIMES, FROM INFLUENT AND EFFLUENT FROM THE TREATMENT PLANT, AND FROM THE OXIDATION LAGOON. THEY WERE THEN ANALYZED FOR NH3-NITROGEN, NO3-NITROGEN, ORGANIC NITROGEN, ORGANIC CARBON, CARBONATE ALKALINITY, BICARBONATE ALKALINITY, ORTHOPHOSPHORUS, TOTAL PHOSPHORUS, 5 DAY BOD, 30 DAY BOD, AND COD. FROM THE PRECEDING INVESTIGATIONS, IT WAS DETERMINED THAT DEPRESSED OXYGEN LEVELS WERE THE RESULT OF BOTH PHYSICAL AND BIOLOGICAL FACTORS. PHYSICALLY, THE DEEPENING OF THE CHANNEL REDUCED TIDAL VELOCITY AND THEREBY REDUCED TURBULENCE AND RATE OF NATURAL RE-OXYGENATION, LEADING TO LOWER OXYGEN TRANSFER RATES. BIOLOGICALLY, ALGAE THRIVES IN BOTH THE OXIDATION PONDS AND THE SHALLOW RIVER, BUT IS TRAPPED IN THE DEEPER CHANNEL WHERE LIGHT PENTRATION IS INSUFFICIENT TO SUPPORT IT. THE ALGAE THEN DECOMPOSES AND REQUIRES OXYGEN. THE PROBLEM THEN, IS A COMPLEX COMBINATION OF FACTORS WHICH REQUIRES THE SYSTEM APPROACH, IF A FULLY COMPREHENSIVE SOLUTION IS TO BE OBTAINED.

PRACTICAL ASPECTS OF THE DESIGN OF WASTE STABILIZATION PONDS.
BARLOW, W. D.
PROC 9TH STH MUNIC INDUSTR WASTE CONF, P 65-70, 1960.
*FINISHING WASTES.
05F
LAGOONS CAN BE DESIGNED TO PROVIDE COMPLETE TREATMENT FOR ANY WASTE WATER, DOMESTIC AND/OR INDUSTRIAL, PROVIDED IT CONTAINS THE NECESSARY NUTRIENTS AND IS FREE FROM SUBSTANCES WHICH ARE TOXIC TO BACTERIA OR ALGAE. THE AUTHOR DISCUSSES THE BASIC PROCESSES INVOLVED; FACTORS AFFECTING THE DESIGN AND OPERATION OF THE LAGOON (PARTICULARLY UNDER CONDITIONS IN NORTH AND SOUTH CAROLINA); PERFORMANCE OF THE LAGOON, INCLUDING METHODS OF MEASUREMENT; AND PRECAUTIONS TO BE TAKEN TO AVOID HEALTH HAZARDS, POLLUTION AND OTHER NUISANCE PROBLEMS. IN DISCUSSION, REFERENCE WAS MADE TO LAGOONS USED FOR TREATING MIXED WASTE WATERS AND 20-30 PER CENT OF DOMESTIC SEWAGE, AND ESPECIALLY TO THE PROBLEMS ENCOUNTERED WHICH APPEAR TO BE CAUSED BY TOXIC METALS IN THE WASTE WATER. (LIVENGOOD-NORTH CAROLINA STATE UNIV)

FARM EFFLUENT--ELECTRICAL DISPOSAL METHODS.
BARRETT, F.
EFFLUENT AND WATER TREATMENT JOURNAL, VOL 11, NO 4, P 207-209, APRIL, 1971, 1 FIG.
*ELECTRICAL DISPOSAL METHODS, *STABILIZATION PONDS, OXIDATION DITCH, *ELECTROLYTIC FLOTATION.
05D;05E
THE GROWTH OF MORE INTENSIVE STOCK FARMING HAS ADDED URGENCY TO THE SEARCH FOR EFFICIENT, ECONOMICAL AND ACCEPTABLE METHODS FOR THE DISPOSAL OF FARM EFFLUENTS. RESEARCH HAS INDICATED THAT EFFLUENT FROM A HERD OF 90-100 COWS CAN BE DEALT WITH EFFICIENTLY AND ECONOMICALLY BY SPRAY AERATION IN A TWO SECTION STABILIZATION POND. PIG EFFLUENT CAN BE MADE RELATIVELY INNOCUOUS BY TREATING IT AEROBICALLY IN AN OXIDATION DITCH SO THAT ITS OXYGEN DEMAND IS MATERIALLY REDUCED BY BIOLOGICAL ACTION. IT IS A PROCESS THAT AVOIDS ODOR PROBLEMS AND WHICH REQUIRES MUCH LESS LAND FOR THE DISPOSAL OF THE RESIDUE THAN WOULD BE REQUIRED FOR UNTREATED EFFLUENT. ELECTROLYTIC FLOTATION USING HYDROGEN AND OXYGEN PRODUCED BY THE ELECTROLYTIC BREAKDOWN OF A SMALL PORTION OF THE WATER IN THE EFFLUENT TO RAISE THE SOLIDS TO THE SURFACE IS A SUITABLE LOW-COST METHOD OF OVERCOMING MOST OF THE DIFFICULTIES IN THE REMOVAL OF SUSPENDED SOLIDS FROM EFFLUENT. (CAMERON-EAST CENTRAL OKLAHOMA STATE)

LIMITING FACTORS IN OXIDATION POND FAILURES.
BARSON, G. M.
WASHINGTON STATE UNIV., PULLMAN.
AVAILABLE FROM UNIVERSITY MICROFILMS 300 N. ZEEB RD. ANN ARBOR, MICH 48106, ORDER NO. 70-18, 939, XEROX COPY $16.90; MICROFILM $4.75. PH. D. DISSERTATION, 1970, 371 P.
05D

SEVERAL HUNDRED VALIDATED CASES OF RAW SEWAGE, FACULTATIVE, AERATED FACULTATIVE, AEROBIC COMPLETE MIX AND TERTIARY OXIDATION PONDS WERE EVALUATED FOR EFFLUENT AND AESTHETIC QUALITY FAILURES IN ACCORDANCE WITH THE ILLINOIS DEPARTMENT OF PUBLIC HEALTH EFFLUENT STANDARDS AND FEDERAL RECEIVING WATER QUALITY CRITERIA. SIGNIFICANT LIMITING FACTORS IN OXIDATION POND FAILURES WERE AVAILABLE SUNLIGHT, LIGHT ATTENUATION AND PHOTOSYNTHETIC OXYGENATION, WIND DRIVEN TURBULENCE AND VERTICAL MIXING, SULFIDE GENERATION AND RECYCLE VERSUS REMOVAL. THE FOLLOWING RECOMMENDATIONS WERE MADE FOR CONTROLLING OXIDATION POND EFFLUENT AND AESTHETIC FAILURES: (1) DESIGN AND USE OF 'ZERO EFFLUENT' LAGOONS, (2) SUPPLEMENTAL ILLUMINATION AND MIXING FOLLOWED BY WASTING AND REMOVAL OF SUSPENDED SOLIDS PRIOR TO DISCHARGE, (3) A TREATMENT PROCESS FOR LAGOONS IN COMPLIANCE WITH ACCEPTED EFFLUENT STANDARDS AND THE INTENT AND OBJECTIVES OF THE 1965 WATER QUALITY ACT. (ALBERT-TEXAS)

EVALUATION OF LAGOON PERFORMANCE IN LIGHT OF 1965 WATER QUALITY ACT.
BARSOM, G. M.; RYCKMAN, D. W.
RYCKMAN, EDGERLEY, TOMLINSON AND ASSOCIATES, CLAYTON, MO.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 63-80, 11 FIG, 8 TAB, 61 REF. USPHS GRANT EH 66-611.
*PUTREFACTION, ILLUMINATION, SUSPENDED SOLIDS, VOLATILE SUSPENDED SOLIDS.
05D
THE BULK OF THE WORK DONE IN THE LAST THREE DECADES ON OXIDATION PONDS HAS BEEN CONCERNED PRIMARILY WITH (1) ALGAL PRODUCTION AND CLASSIFICATION, AND (2) DEVELOPMENT OF DESIGN CRITERIA FOR ORGANIC AND HYDRAULIC LOADINGS OF OXIDATION PONDS. LAGOON PERFORMANCE HAS NEVER BEEN EVALUATED FROM THE POSITION OF WATER QUALITY CRITERIA; NOR HAS A COMPREHENSIVE EFFORT BEEN MADE TO EVALUATE THE PHYSICAL, CHEMICAL, AND BIOLOGICAL LIMITING FACTORS WHICH DEFINE LAGOON PERFORMANCE. THEREFORE AN EVALUATION PROGRAM WAS DEVISED TO RATE LAGOONS ON THE BASIS OF WATER QUALITY CRITERIA AND ALSO ON AESTHETIC SUCCESS OR FAILURE. LAGOONS IN VARYING LOCATIONS WERE STUDIED FOR EXTENDED PERIODS OF TIME AND EVALUATED. THE FOLLOWING OBSERVATIONS WERE MADE BASED ON THE EVALUATIONS: (1) EFFLUENT 5 DAY BOD FROM LAGOONS GREATLY EXCEEDED THE ACCEPTED EFFLUENT BOD STANDARDS, AS DID SUSPENDED SOLIDS BOTH IN THE CASE OF RAW SEWAGE, AND TERTIARY OXIDATION PONDS, AND (2) REMOVAL OF PHOSPHATES, NITRATES, AND COLIFORMS WAS BOTH IN-EFFECTIVE AND ERRATIC. BASED UPON REDUCTION OF COD SS, VSS, NITROGEN, AND PHOSPHORUS, OXIDATION PONDS DID NOT SIGNIFICANTLY ENHANCE WATER QUALITY, AND AS PRESENTLY DESIGNED, SUCH PONDS WILL NOT ENHANCE, RESTORE, OR EVEN MAINTAIN THE PRESENT QUALITY OF RECEIVING WATERS.

BIOLOGICAL FACTORS IN TREATMENT OF RAW SEWAGE IN ARTIFICIAL PONDS.
BARTSCH, A. F.; ALLUM, M. O.
ROBERT A. TAFT SANITARY ENGINEERING CENTER, CINCINNATI, OHIO; AND SOUTH DAKOTA STATE COLL., BROOKING
IN: BIOLOGY OF WATER POLLUTION, P 262-269. COMPILED BY L. E. KEUP, W. M. INGRAM, AND K. M. MACKENTHUN, FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, WASHINGTON, D. C., 1967. 6 FIG, 7 TAB, 18 REF.
*PHOTOSYNTHETIC OXYGEN, LEMMON(SD), KADOKA(SD).
05D;05C
FREEDOM FROM NUISANCE CONDITIONS AND THE ACCEPTABILITY OF RAW SEWAGE PONDS TO MUNICIPALITIES AS TREATMENT FACILITIES ARE INTIMATELY DEPENDENT UPON THE DISSOLVED OXYGEN SUPPLY IN SEWAGE. LIGHT AND DARK BOTTLE ANALYSES AND THE ESTIMATED OXYGEN PRODUCTION BASED ON VERDUIN'S FACTOR PERMIT ESTABLISHMENT OF SUITABLE LOADING AND DEPTH OF SEWAGE LAGOONS. THE USE OF POND DESIGN EQUATIONS, HOWEVER, REQUIRES CAUTION BECAUSE PROFILE VARIATIONS, WEATHER CONDITIONS, DIURNAL CHANGES AND OTHER FACTORS MAY IMPOSE CONSIDERABLE DEVIATION IN DESIGN.

AERATED LAGOONS-A REPORT ON THE STATE OF THE ART.
BARTSCH, ERIC H.; RANDALL, CLIFFORD W.
VIRGINIA POLYTECHNIC INST., BLACKSBURG.
JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 43, NO 4, APRIL 1971, P 699-708, 6 FIG, 1 TAB, 7 REF.
*AERATED LAGOONS, *REACTION RATES, *SUSPENDED SOLIDS.
05D
A FULL-SCALE AERATED LAGOON WAS MONITORED TO PROVIDE CONSIDERABLE OPERATIONAL DATA IN ORDER TO EVALUATE CRITICALLY THE TEMPERATURE PREDICTION AND EFFECTS FORMULATION. THE LAGOON STUDIED TREATED 0.7 MGD OF TEXTILE-FINISHING PLANT WASTEWATER. THE EFFICIENCY OF THE AERATED LAGOON SYSTEM WAS STRONGLY TEMPERATURE DEPENDENT BELOW 50 DEG F, AND STRONGLY TEMPERATURE INDEPENDENT ABOVE 50 DEG F. PRESENT THEORY DID NOT PREDICT AERATED LAGOON REACTION RATES ACCURATELY, PARTICULARLY FOR TEMPERATURES LESS

THAN 12 DEG C. HOWEVER, THE ECKENFELDER FORMULA ACCURATELY PREDICTED LAGOON TEMPERATURE FROM AIR AND WASTE TEMPERATURES IF THERMAL EQUILIBRIUM BETWEEN THE LAGOON AND THE ATMOSPHERE HAD BEEN REACHED. FURTHER RESEARCH INDICATED THAT ALTHOUGH AERATED LAGOONS PROVIDE GOOD QUALITY EFFLUENT AT LOW POWER INPUT AND A SAVINGS IN LAND AREA MOST OF THE YEAR, WINTERTIME OPERATION BECOMES MARGINAL DUE TO SLOWER REACTION RATES AND INCREASED RESIDENCE TIMES. WITH SUBSEQUENT INCREASED PER UNIT POWER COSTS. ADDITIONAL INFORMATION IS NEEDED CONCERNING THE VARIOUS OPERATING VARIABLES TO PERMIT RATIONAL DECISIONS TO BE MADE. (LOWRY-TEXAS)

ADVANCED AND LOW-COST TREATMENT OF PULP MILL WASTES (TRAITEMENT AVANCE' ET TRAITEMENT COUTEUX DES EAUX USE'ES DE L' INDUSTIE DE LA PATE A PAPIER).
BASU, A. K.
CENTRAL PUBLIC HEALTH ENGINEERING RESEARCH INST., CALCUTTA(INDIA).
TRIBUNE CENTRE BELGE D'ETUDE ET DE DOCUMENTATION DES EAUX, VOL. 27, NO. 371, P 419-423, OCTOBER, 1974.
2 FIG, 5 REF, 6 TAB.
KRAFT MILLS, SULFITE PULP MILLS, INDIA.
05D;03E
THIS ARTICLE REPORTS LABORATORY EXPERIMENTS WITH A NEW METHOD OF PURIFYING MILL EFFLUENTS, AND REVIEWS WORK DONE IN INDIA ON LOW-COST TREATMENT METHODS. BOTH THE NEW ADVANCED TREATMENT AND THE LOW-COST TREATMENT ARE OF INTEREST FOR INDUSTRIALIZED AND DEVELOPING COUNTRIES, THE SECOND PROCESS BEING OF PARTICULAR INTEREST IN TROPICAL AND SUBTROPICAL ZONES. THE LABORATORY EXPERIMENTS CONSISTED OF PASSING A 220 VOLT ALTERNATING CURRENT THROUGH AN EFFLUENT SAMPLE FOR UP TO 15 MINUTES, WITH COPPER AND DURALUMINUM ELECTRODES EXCELLENT CLARIFICATION OF KRAFT MILL EFFLUENT OBTAINED (REDUCTIONS OF TURBIDITY, COLOR, ODOR, SOLIDS, AND LIGNIN CONTENT, AND COD). RESULTS WITH SULFITE MILL EFFLUENTS WERE NOT ENCOURAGING. THE ELECTRIC TREATMENT REQUIRE FURTHER PILOT PLANT STUDIES AND INDUSTRIAL TESTS, AS WELL AS COST ESTIMATES. THE LOW-COST TREATMENT INVOLVES THE USE OF STABILIZATION BASINS, AERATION LAGOONS, AND OXICATION PONDS. THE REDUCTION OF BOD IS UP TO 95-98%, I.E., COMPARABLE TO THAT OBTAINED IN CONVENTIONAL TREATMENT (PERCOLATION FILTERS). TWO LOW-COST SYSTEMS ARE ILLUSTRATED WITH DIAGRAMS. ONE INVOLVES THE USE OF ANAEROBIC LAGOONS AND AERATED LAGOONS, THE OTHER (FOR COMBINED PAPER, PULPING, AND BLEACHING EFFLUENTS) INCLUDES STORAGE, ANAEROBIC, AERATED LAGOONS, AND AN OXIDATION POND. IT IS OF PARTICULAR INTEREST FOR MILLS HAVING SUFFICIENT CHEAP LAND AVAILABLE UNDER CONDITIONS OF HOT CLIMATE AND CHEAP LABOR. (STAPINSKI-IPC).

PURIFICATION OF WASTE WATERS BY MEANS OF AERATED LAGOONS (L'EPURATION DES EAUX RESIDUAIRES PAR LAGUNAGE AERE).
BEBIN, J.
PAPIER, CARTON ET CELLULOSE, VOL 21, NO 4, P 31-41, APRIL 1972. 3 FIG, 3 ILLUS, 1 TAB, 28 REF.
KRAFT MILLS, CLARIFICATION, RESIDENCE TIME, OPERATING VARIABLES, *FRANCE(BAUPTE), *SWEDEN(FROVIFORS).
05D
THE FOUR MAIN TYPES OF EFFLUENT-TREATING LAGOONS, NAMELY, ANAEROBIC, AEROBIC, AERATED, AND FACULTATIVELY AERATED, ARE COMPARED. THE THEORETICAL PRINCIPLE AND PRACTICAL OPERATION ARE DISCUSSED OF LAGOONS IN COMMERCIAL USE, MOST OF WHICH ARE ONLY FACULTATIVELY AERATED, SINCE THEY DO NOT MAINTAIN ALL PARTICLES IN CONSTANTLY AGITATED SUSPENSION. OPERATING VARIABLES DISCUSSED AND PERTINENT CALCULATIONS PRESENTED INCLUDE TEMPERATURE, RESIDENCE TIME, OXYGEN DEMANDS, AERATION OR OXYGENATION, SLUDGE PRODUCTION, ULTIMATE CLARIFICATION AND STABILIZATION NEEDS OF VARIOUS INDUSTRIAL AND DOMESTIC WASTES, AND LAGOON DESIGN AND CONSTRUCTION PARAMETERS, SUCH AS EROSION CONTROL. TWO CASE HISTORIES OF INDUSTRIAL LAGOON INSTALLATIONS ARE DESCRIBED, ONE AT ETABLISSEMENTS AUBY IN BAUPTE, FRANCE, WHERE GELLING AGENTS, STABILIZERS, AND OTHER CHEMICALS ARE EXTRACTED FROM MARINE ALGAE, THE OTHER AT CREBRO PAPPERSBRUKS AB, IN FROVIFORS, SWEDEN, A KRAFT PULP AND PAPER MILL. (SPECKHARD-IPC)

WASTE TREATMENT VARIABLES FOR KRAFT MILLS,
BODENHEIMER, V. E.
PAPER INDUSTRY ENGINEERS, INC., ATLANTA, GA.
SOUTHERN PULP AND PAPER MANUFACTURER, VOL 38, NO 7, P 29-32, JULY, 1975, 2 FIG, 2 REF, 4 TAB.
*KRAFT MILLS, *NSSC PULP MILLS,
05D
IMPORTANT PARAMETERS AFFECTING THE OPERATION OF NATURALLY AND ARTIFICALLY AERATED LAGOONS AND CONVENTIONAL AND OXYGEN-AIDED ACTIVATED SLUDGE SYSTEMS TREATING KRAFT MILL AND KRAFT/NEUTRAL SULFITE SEMICHEMICAL MILL WASTES ARE DEFINED. FORMULAS ARE GIVEN SHOWING THE EFFECTS OF INITIAL BOD,

TEMPERATURE, TIME (RETENTION TIME IN DAYS), AND DEPTH ON THE FINAL BOD OF EFFLUENT TREATED IN NATURALLY AND ARTIFICALLY AERATED LAGOONS. IN THE ACTIVATED SLUDGE TREATMENT SYSTEMS, FINAL BOD OF THE TREATED EFFLUENT DEPENDS ON THE INITIAL BOD, MIXED LIQUOR SUSPENDED SOLIDS (SUSPENDED SOLIDS CONCENTRATION AFTER MIXING OF INFLUENT WASTE AND RECYCLED SLUDGE), TEMPERATURE, AND A TIME FACTOR (ROUGHLY EQUIVALENT TO THE TOTAL AERATION TIME IN DAYS). THE FORMULAS ARE OF VALUE FOR WASTE TREATMENT SYSTEM DESIGN AND CONTROL PURPOSES. SUSPENDED SOLIDS REMOVAL IS AN AREA THAT NEEDS MORE STUDY. THE BEST CONSENSUS IS THAT THE STANDARD FOR SUSPENDED SOLIDS FOR BLEACHED KRAFT PULP IS 5.5 LB/TON. TREATMENT SYSTEMS MEETING THIS STANDARD ARE NATURAL LAGOONS OR LOW-RATE AERATED SYSTEMS HAVING AT LEAST 26 DAYS TOTAL RETENTION TIME. THE ADVANTAGES AND DISADVANTAGES OF NATURALLY AND ARTIFICIALLY AERATED LAGOONS AND CONVENTIONAL ACTIVATED SLUDGE TREATMENT ARE LISTED. (WITT-IPC)

THE USE OF ALGAE IN REMOVING NUTRIENTS FROM DOMESTIC SEWAGE.
BOGAN, R. H.
WASHINGTON UNIV., SEATTLE.
TRANS 1960 SEM ON ALGAE AND METRO WASTES, ROBT A TAFT SANITARY ENGG CENTER, CINCINNATI, OHIO, TECH REPT W61-3, PP 140-147, 1961. 8 P.
STIGEOCLONIUS, INSOLUBLE WASTES, CULTURE MEDIA.
05D
THE SOLUBLE ORGANIC PHOSPHORUS IN SEWAGE MAY BE CONVERTED BY BIOLOGICAL OR CHEMICAL MEANS INTO RECOVERABLE INSOLUBLE MATTER. THE LATTER MEANS HAS RECEIVED MORE ATTENTION TO DATE. THE RATE OF REMOVAL BY BIOLOGICAL MEANS IS A FUNCTION OF CELL-TISSUE SYNTHESIS WHICH VARIES MARKEDLY WITH THE TYPE OF ORGANISM. THE MIXED MICROBIAL CULTURES PROVIDED BY THE ACTIVATED SLUDGE PROCESS APPEAR TO BE THE MOST RAPID MECHANISM. CHLORELLA, SCENEDESMUS, AND STIGEOCLONIUS WERE GROWN IN RAW AND TREATED SEWAGE FOR THE EXPERIMENTS, AND THE AUTHOR STUDIED THEIR ROLE IN ADJUSTING PH, TEMPERATURE, CELL-TISSUE CONCENTRATION, COMPOSITION OF CULTURE MEDIA, AND ALKALINITY INFLUENCE THE RATE OF PHOTOSYNTHETIC PH ADJUSTMENT, WITH ADEQUATE LIGHT, THE MINIMUM VALUE BEING 100-200 F C, RAPID EXTRACTION OF PHOSPHORUS BY PHOTOSYNTHETIC BIOLOGICAL ACTIVITY IS POSSIBLE. A HIGH-RATE PROCESS WAS DEVELOPED IN THE LABORATORY BY WHICH SOLUBLE PHOSPHORUS REDUCTIONS OF 90 PERCENT OR MORE WERE ACHIEVED IN CONTACT TIMES OF AS LITTLE AS 6-12 HOURS. TRANSFERRING THE PILOT-PLANT STUDY TO LAGOONAL WATERS 3-4 FT DEEP CREATED LIGHTING PROBLEMS--SUNLIGHT COULD NOT PENETRATE DEEPLY ENOUGH THROUGH THE ALGAL GROWTH TO CAUSE AN ADEQUATE PHOTOSYNTHETIC RESPONSE.

THE DEWATERING OF LIME-ALGAE SLUDGE ON SAND DRYING BEDS
BOND, N. T.; MITCHELL, G. F.
MISSISSIPPI STATE UNIV., MISSISSIPPI STATE, DEPT. OF CIVIL ENGINEERING.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-288 941, IN PAPER COPY, IN MICROFICHE. MISSISSIPPI WATER RESOURCES RESEARCH INSTITUTE REPORT SEPTEMBER 1978. 73 P, 45 FIG, 2 TAB, 13 REF, 2 APPEND. OWRT A-110-MISS(1), 1434-0001-0026.
FIELD 05D
REMOVAL OF ALGAE FROM STABILIZATION POND EFFLUENTS IS REQUIRED FOR THE EFFLUENT TO MEET CURRENT FEDERAL DISCHARGE STANDARDS. APPLICATION OF A THICKENED LIME-ALGAE SLUDGE TO SAND DRYING BEDS WAS INVESTIGATED AS A TREATMENT METHOD. THE SLUDGE WAS LOADED AT RATES OF 4.0 TO 16.1 GAL/FT2 TO SAND BED COLUMNS WITH MEDIA DEPTHS OF 6 TO 12 INCHES. A SLUDGE CAKE WITH AN AVERAGE 25% SOLID CONTENT WAS OBTAINED WITHIN TEN HOURS AT BED DEPTHS OF 6 TO INCHES OVER THE LOADINGS APPLIED. WHILE 65 HOURS WERE REQUIRED FOR A BED DEPTH OF 12 INCHES AT LOADINGS ABOVE 12 GAL/FT2. INVESTIGATIONS INDICATED THAT DEWATERING RATE AND EFFLUENT QUALITY WERE NOT RELATED TO MEDIA SIZE FROM 0.3 TO 1.5 MM. DEWATERING RATES DECREASED WITH INCREASING SOLIDS LOADING FROM ABOUT 1 TO 6 LBS/FT2; HOWEVER, EFFLUENT QUALITY AND SLUDGE CAKE SOLIDS DID NOT APPEAR TO BE AFFECTD BY SOLIDS LOADING. DEWATERING RATES ABOVE 1 GAL/FT2/HR WERE NOTED AT A BED DEPTH F 10 INCHES. EFFLUENT SUSPENDED SOLIDS FROM THE DRYING BEDS AVERAGED 100 MG/L. SUPERNATE WITHDRAWAL SIGNIFICANTLY DECREASED THE DEWATERING TIME AT THE 12-INCH BED DEPTH; HOWEVER, THE SUPERNATE AVERAGED 175 MG/L OF TOTAL SUSPENDED SOLIDS, WHICH WOULD REQUIRE RECIRCULATION TO THE LAGOON.

DUAL MEDIA FILTRATION OF WASTE STABILIZATION POND EFFLUENT.
BOND, N. T.
MISSISSIPPI STATE UNIV., MISSISSIPPI STATE, DEPT. OF CHEMICAL ENGINEERING.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-273 769, IN PAPER COPY, IN MICROFICHE. MISSISSIPPI STATE UNIVERSITY, WATER RESOURCES RESEARCH INSTITUTE, COMPLETION REPORT, SEPTEMBER 1977. 52 P, 22 FIG, 5 TAB, 16 REF, APPEND. OWRT A-107-MISS(1), 14-34-0001-7052.
*DUAL MEDIA FILTRATION, SAND FILTERS, COAL FILTERS.

THIS LABORATORY STUDY EXAMINED THE POSSIBILITY OF USING DUAL MEDIA FILTRATION AS A METHOD TO REMOVE SUSPENDED SOLIDS FROM WASTE STABILIZATION POND EFFLUENTS. THREE FILTERS WERE USED. FILTER BEDS WERE CONSTRUCTED BY PLACING A LAYER OF COAL ON TOP OF A LAYER OF SAND. A MINIMUM AMOUNT OF INTERMIXING OF THE TWO MATERIALS OCCURRED WHEN THE FILTERS WERE BACKWASHED. FILTER SANDS HAVING AN EFFECTIVE GRAIN SIZE OF 0.2, 0.4 AND 0.6 MM WERE USED TO PACK SIX-INCH DIAMETER PLEXIGLAS COLUMNS TO A DEPTH OF 24 INCHES. ALL COAL MEDIA HAD AN EFFECTIVE SIZE OF 0.9 MM, A UNIFORMITY COEFFICIENT OF 1.5, AND AN IN-COLUMN DEPTH OF 6 INCHES. FILTERS WERE OPERATED BOTH WITH AND WITHOUT THE ADDITION OF COAL TO THE BEDS. MAXIMUM REMOVAL OF SUSPENDED SOLIDS WAS APPROXIMATELY 50% FOR THE 0.2 MM EFFECTIVE GRAIN SIZE DUAL MEDIA FILTERS. FILTERS COULD BE OPERATED FOR ONLY 8 TO 14 HOURS BEFORE CLOGGING. NITROGEN AND PHOSPHORUS REMOVAL BY THE FILTERS WAS ORGANICALLY BOUND MATERIAL, CONTAINED IN THE CELLS OF ALGAE, AND OTHER MATTER WAS RETAINED IN THE MEDIA. BACKWASH REQUIREMENTS FOR CLEANING THE 0.2 MM SAND WERE MUCH LESS THAN FOR THE COARSE FILTERS. DUAL MEDIA FILTERS WERE MUCH EASIER TO CLEAN THAN SAND FILTERS.

REMOVAL OF ALGAE FROM WASTE STABILIZATION POND EFFLUENT.
BOND, R. T.
MISSISSIPPI STATE UNIV., MISSISSIPPI STATE DEPT. OF CIVIL ENGINEERING.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA., 22161 AS PB-256 512 $4.50 IN PAPER COPY, $3.00 IN MICROFICHE. MISSISSIPPI WATER RESOURCES RESEARCH INSTITUTE, MISSISSIPPI STATE, COMPLETION REPORT JULY 1976. 56 P, 17 FIG, 6 TAB, 22 REF, 4 APPEND. OWRT A-096-MISS(1).
*ALUM TREATMENT.
SD
THE OBJECTIVES WERE: (1) TO DETERMINE THE VARIANCES OF SELECTED PARAMETERS FOR WASTE STABILIZATION POND EFFLUENTS TREATED WITH ALUM ALONE AND WITH ALUM USED WITH POLYELECTROLYTES AND (2) TO DETERMINE THE SLUDGE VOLUME AND CHARACTERISTICS PRODUCED IN THE PHYSICAL-CHEMICAL PROCESS. IN ADDITION, THE USE OF LIME IN PLACE OF ALUM WAS STUDIED. EFFLUENTS WERE COLLECTED FOR FOUR SAMPLING CONDITIONS AND TREATED IN THE LABORATORY TO DETERMINE CHEMICAL REQUIREMENTS AND SLUDGE CHARACTERISTICS. ALUM REQUIREMENTS WERE IN THE RANGE OF 60 TO 100 MG/L WHILE LIME (CA(OH)2) REQUIREMENTS VARIED FROM 250 TO 600 MG/L. VARIOUS POLYELECTROLYTES WERE TRIED AND PRODUCED FAIR RESULTS WHEN CATIONIC POLYMERS WERE USED IN CONCENTRATIONS GREATER THAN 15 MG/L. THE RESULTS FROM CHEMICAL-POLYMER SYSTEMS WERE ONLY A LITTLE BETTER THAN THOSE USING CHEMICALS ONLY. AN EQUATION HAS BEEN PROPOSED THAT RELATES ALUM SLUDGE VOLUME PRODUCED TO SUSPENDED SOLIDS REMOVED. THE SLUDGE WAS FOUND TO SEPARATE RAPIDLY AND TO BE THICKENED TO A SIGNIFICANT DEGREE BY GRAVITY. RESULTS OF THE TRADITIONAL SPECIFIC RESISTANCE TO FILTRATION AND THE FILTER LEAF TESTS INDICATE THAT VACUUM FILTRATION OF THE SLUDGE WOULD NOT BE EFFECTIVE. A POSSIBLE EXCEPTION MAY BE PRECOAT FILTRATION OF LIME SLUDGE.

A STUDY OF THE FATE OF BIOSOLIDS FROM BIOLOGICALLY TREATED EFFLUENT IN LABORATORY AND CONSTRUCTED STREAMS
DORTON, D. L.; COSTA, H.; GREEN, W.
NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT, INC., NEW YORK.
NCASI STREAM IMPROVEMENT TECHNICAL BULLETIN, NO. 308, 18 P, APRIL, 1978. 4 FIG, 6 REF, 1 TAB.
FIELD 05C, 05E
CARBON-14 LABELED SUSPENDED SOLIDS FROM A LABORATORY AERATED STABILIZATION BASIN FED BLEACHED KRAFT MILL EFFLUENT WERE INTRODUCED INTO LABORATORY STREAMS, AND THEIR UPTAKE INTO THE PERIPHYTON AND MACROINVERTEBRATE COMMUNITY WAS MONITORED. OVER 95% OF THE BIOSOLIDS MEASURED AS TOTAL SUSPENDED SOLIDS (TSS) IN THE FULL-SCALE AND LABORATORY STABILIZATION BASINS WERE OF BACTERIAL ORIGIN. SOME BIOSOLIDS WERE QUICKLY INGESTED BY A VARIETY OF INVERTEBRATES, INCLUDING BOTH GRAZING AND FILTER FEEDING ORGANISMS. SOME ORGANIC MATERIALS FROM THE INGESTED BIOSOLIDS WERE INCORPORATED INTO INVERTEBRATE TISSUE, DEMONSTRATING ONE PATHWAY OF THEIR INCORPORATION INTO THE AQUATIC FOOD CHAIN. THE INTRODUCTION OF 1-2 MG/LITER OF TSS INTO THE STREAMS FOR OVER TWO YEARS DID NOT RESULT IN MEASURABLE DIFFERENCES IN THE AMOUNT OF ORGANIC MATTER ACCUMULATED ON THE BOTTOM. (WITT-IPC)

PERFORMANCE EVALUATION OF EXISTING LAGOONS-PETERBOROUGH, NEW HAMPSHIRE
BOWEN, S. P.
JRF SCIENTIFIC CORP., WILMINGTON, MA.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-272 390, IN PAPER COPY, IN MICROFICHE. REPORT EPA-600/2-77-085, AUGUST 1977. 101 P, 6 FIG, 6 TAB, 2 APPEND.
FIELD 05D
THE PERFORMANCE OF WASTE WATER TREATMENT LAGOONS IN PETERBOROUGH, NEW HAMPSHIRE, WAS MONITORED OVER A 12-MONTH PERIOD WITH RESPECT TO FEDERAL STANDARDS FOR EFFLUENT QUALITY. THE TREATMENT PLANT HAD AVERAGE

AND DESIGN FLOWS OF 0.5 MGD AND 2.14 MGD, RESPECTIVELY; THREE TREATMENT LAGOONS WITHOUT AERATION HAD A TOTAL SURFACE AREA OF 21 ACRES. CHLORINATION OF THE TREATED EFFLUENT WAS CONDUCTED BEFORE DISCHARGE. FECAL COLIFORMS AND SUSPENDED SOLIDS WERE EFFICIENTLY REMOVED DURING THE ENTIRE STUDY; BOD AND COD WERE ADEQUATELY REDUCED DURING ALL BUT FOUR MONTHS OF THE STUDY. DURING THESE WINTER MONTHS, TOTAL BOD WAS REDUCED BY 60% TO ABOUT 52 MG/LITER AND PH DROPPED TO BELOW 6.0. THE REDUCED EFFICIENTY OF THE TREATMENT LAGOONS WAS ATTRIBUTED TO ANAEROBIC CONDITIONS CREATED BY AN ICE COVER. THE INSTALLATION OF INDUCED AIR AERATION EQUIPMENT IN ONE OR MORE PONDS WAS RECOMMENDED. A 27% SEEPAGE LOSS WAS RECORDED IN THE PLANT WHICH WAS BOD AND HYDRAULICALLY UNDERLOADED. AVERAGE EFFLUENT DISSOLVED OXYGEN LEVELS OF 2 MG/LITER DROPPED TO ZERO DURING THE WINTER MONTHS; AMMONIA-NITROGEN CONCENTRATIONS INCREASED AND NITRATE-NITROGEN DECREASED DURING THE COLD PERIODS. TOTAL PHOSPHORUS WAS REDUCED BY ABOUT 10% FOR THE YEAR; NITRATE-NITROGEN WAS REMOVED TO BELOW DETECTABLE LEVELS. ALKALINITY DOUBLED DURING THE WINTER MONTHS BECAUSE OF THE NECESSARY INCREASE IN RESIDUAL CHLORINE LEVELS FROM 2 MG/LITER TO 40-50 MG/LITER.

STABILIZATION LAGOONS INCLUDING EXPERIENCE IN BRAZIL.
BRADLEY, R. M.; SILVA, M. O. S. ALVARES DA
BALFOUR (D.) AND SONS, SAO PAULO (BRAZIL).
EFFLUENT AND WATER TREATMENT JOURNAL, VOL 17, NO 1, P 21-23, 26-29, JANUARY, 1977. 3 FIG, 4 TAB.

*BRAZIL, FACULTATIVE LAGOONS.
05D
DESIGN CRITERIA AND OPERATION DATA FOR LAGOON SYSTEMS TREATING DOMESTIC SEWAGE IN BRAZIL WERE DISCUSSED. THERE IS NO INTERNATIONALLY ACCEPTED DESIGN PROCEDURE FOR STABILIZATION LAGOONS SINCE THEIR OPERATION EFFICIENCY DEPENDS ON THE CLIMATIC CONDITIONS OF A GIVEN AREA. WITH ADEQUATE AVAILABLE LAND, THESE LAGOONS ARE AN INEXPENSIVE MEANS FOR REDUCING DOMESTIC SEWAGE BOD. GREATER EFFICIENCY, AS WELL AS LAND AND EXCAVATION SAVINGS, RESULT FROM USING AN ANAEROBIC AND FACULTATIVE LAGOON IN SERIES. IN BRAZIL, USING THIS METHOD RATHER THAN A SINGLE FACULTATIVE LAGOON PRODUCES A 70% REDUCTION IN LAND AREA REQUIREMENTS. A 45% REDUCTION IN EXCAVATION VOLUME, AND A 55% DETENTION TIME REDUCTION, WHILE YIELDING AN EFFLUENT OF THE SAME QUALITY. FACULTATIVE LAGOONS ALWAYS CONTAIN ALGAE. WHEN 85-90% BOD REMOVALS ARE NECESSARY, ALGAL REMOVAL SHOULD BE PRACTICED. FACULTATIVE LAGOONS PRODUCE AN EFFLUENT WITH SUBSTANTIAL SUSPENDED SOLIDS, MAINLY ALGAE, WHICH ARE HARMFUL TO RECEIVING STREAMS. AERATED AEROBIC LAGOONS HAVE A HIGHER OPERATIONAL COST AND PRODUCE AN EFFLUENT HIGHER IN SUSPENDED SOLIDS CONCENTRATIONS THAN FACULTATIVE LAGOONS. BRAZILIAN PRACTICE IS TO ACCEPT THE ALGAE PROBLEMS IN ORDER TO ACHIEVE, OVER THE WIDEST AREA POSSIBLE, SOME MEASURE OF REDUCTION IN THE ORGANIC LOADS DISCHARGED TO RIVERS. BASIC SANITATION CAN THUS BE PROVIDED TO AS MANY COMMUNITIES AS POSSIBLE, AND EFFLUENT QUALITY CAN BE IMPROVED AS FINANCIAL RESOURCES INCREASE. IN DENSELY POPULATED AREAS, BECAUSE LAND IS SCARCE AND EFFLUENT QUALITY STANDARDS ARE TO BE RAISED, IT IS USUAL TO USE AERATED LAGOONS WHICH ARE CONVERTIBLE TO ACTIVATED SLUDGE SYSTEMS. (COLLINS-FIRL)

THE EFFECTS OF NITROGEN REMOVAL ON THE ALGAL GROWTH POTENTIAL OF SAN JOAQUIN VALLEY AGRICULTURAL TILE DRAINAGE EFFLUENTS.
BROWN, RANDALL L.; BAIN, RICHARD C., JR.; TUNZI, MILTON G.
CALIFORNIA STATE DEPT. OF WATER RESOURCES, FRESNO; AND FEDERAL WATER QUALITY ADMINISTRATION, ALAMEDA IN: COLLECTED PAPERS REGARDING NITRATES IN AGRICULTURAL WASTE WATERS. FEDERAL WATER QUALITY ADMINISTRATION WATER POLLUTION CONTROL RESEARCH SERIES 13030 ELY. 12/69. P 143-155. DECEMBER 1969. 13 P, 4 FIG, 4 TAB, 3 REF. FWQA PROJECT 13030 ELY.
*CENTRAL VALLEY(CALIFORNIA), *BACTERIAL DENITRIFICATION.
05D;05B
LABORATORY CULTURE EXPERIMENTS WERE MADE TO DETERMINE THE EFFECTIVENESS OF THE TWO BIOLOGICAL PROCESSES UNDER INVESTIGATION, ALGAL STRIPPING AND BACTERIAL DENITRIFICATION, FOR REMOVING THE ALGAL GROWTH POTENTIAL OF THE TILE DRAINAGE WATER WHEN ADDED TO POTENTIAL RECEIVING WATERS IN THE SACRAMENTO-SAN JOAQUIN DELTA. ALGAL GROWTH POTENTIAL TESTS IN TWO DIFFERENT LABORATORIES INDICATE THAT NITRATE-RICH AGRICULTURAL DRAINAGE, WHEN MIXED WITH SAN JOAQUIN RIVER DELTA WATER, STIMULATES ALGAL GROWTH. SELECTIVE REMOVAL OF NITRATE-NITROGEN BY ANAEROBIC DENITRIFICATION OR REMOVAL OF NUTRIENTS BY ALGAL CELLS GROWN IN SHALLOW PONDS YIELDED COMPARABLE BIOASSAY RESULTS. EUTROPHICATION DUE TO AGRICULTURAL WASTE WATERS CAN BE CONTROLLED BY TREATMENT.

A COMPARATIVE STUDY OF AERATED LAGOON TREATMENT OF MUNICIPAL WASTE WATERS.
BURNS, G. E.; GIRLING, R. M.; PICK, A. R.; VAN ES, D. W.
METROPOLITAN CORP. OF GREATER WINNIPEG (MANITOBA). WATER WORKS AND WASTE DISPOSAL DIV.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P

258-276. 14 FIG, 3 TAB, 6 REF.
*AERATED LAGOONS, SURFACE AERATORS.
05D
THREE PILOT SCALE AERATED LAGOONS WERE CONSTRUCTED AT WINNIPEG, CANADA TO TEST THE EFFECT OF THE CANADIAN PRAIRIE CLIMATIC CONDITIONS ON LAGOON OPERATION. THE PILOT CELLS WERE OF THE ANAEROBIC-AEROBIC TYPE. EACH LAGOON WAS EQUIPPED WITH A DIFFERENT TYPE OF AERATION SYSTEM, DIFFUSED AIR, SURFACE AERATORS, OR A COMBINATION OF BOTH. TEST WERE CONDUCTED OVER A 20 MONTH PERIOD ON AN INFLUENT AVERAGING 175 MG/L BOD AND 188 MG/L OF SUSPENDED SOLIDS. FROM THE RESULTS OF THIS INVESTIGATION, IT WAS CONCLUDED THAT AERATED LAGOONS CAN SATISFACTORILY PROVIDE SECONDARY TREATMENT UNDER PRAIRIE CLIMATIC CONDITIONS. BOD REMOVAL EFFICIENCY AND DISSOLVED OXYGEN CONCENTRATION BOTH UNDERGO A SEASONAL SUMMER DECLINE DUE TO THE BUILD-UP OF SLUDGE DURING THE SUMMER MONTHS. THE PREVAILING CONSIDERATION FOR ECONOMIC FEASIBILITY OF AN AERATED LAGOON SYSTEM IS THE EXTENT AND COST IMPLICATIONS OF SLUDGE REMOVAL AND DISPOSAL FACILITIES. ALSO THE USE OF SURFACE AERATORS WAS DEMONSTRATED TO BE IMPRACTICAL IN AREAS WHICH SUSTAIN LARGE AMOUNTS OF ICE COVER. RESEARCH IS CONTINUING ON THE ECONOMIC FACTORS INVOLVED IN SLUDGE REMOVAL AND DISPOSAL.

HARVESTING OF ALGAE GROWN IN AGRICULTURAL WASTE WATERS.
BUTTERFIELD, BRUCE A.; JONES, JAMES R.
CALIFORNIA STATE DEPT. OF WATER RESOURCES, FRESNO; AND BUREAU OF RECLAMATION, FRESNO, CALIF.
IN: COLLECTED PAPERS REGARDING NITRATES IN AGRICULTURAL WASTE WATERS, FEDERAL WATER QUALITY ADMINISTRATION WATER POLLUTION CONTROL RESEARCH SERIES 13030 ELY, 12/69, P 157-163, DECEMBER 1969. 7 P, 1 TAB, FWQA PROJECT 13030 ELY.
*ALGAE HARVESTING, *CENTRAL VALLEY(CALIF.).
05D;05B
THROUGH LABORATORY AND FIELD TESTING OF ALGAE HARVESTING METHODS FOR DENITRIFICATION, IT WAS SHOWN THAT EFFECTIVE CONCENTRATION CAN BE ACCOMPLISHED USING THE FLOCCULATION-SEDIMENTATION PROCESS TO REMOVE 90-95 PERCENT OF THE SUSPENDED SOLIDS FROM ALGAE-LADEN AGRICULTURAL WASTE WATER. DEWATERING AND DRYING CAN BE ACCOMPLISHED BUT THE EFFICIENCIES OF THE UNITS TESTED WERE LOW. THE NEED TO RECIRCULATE THE WATER WOULD INCREASE THE OVERALL COST; HOWEVER, IT IS BELIEVED BETTER RESULTS WILL BE ACHIEVED IN LARGER CAPACITY UNITS.

REMOVAL OF ALGAL NUTRIENTS FROM RAW WASTEWATER WITH LIME.
DUZZELL, J. C.; SAWYER, C. N.
METCALF AND EDDY, BOSTON, MASS.
WATER POLL CONTROL FED JOUR, VOL 39, NO 10, R16-R24 OCT 1967.
*NUTRIENTS, PONDS, PRIMARY TREATMENT, SECONDARY TREATMENT, STABILIZATION PONDS, SEWAGE LAGOONS.
05D
A LABORATORY EVALUATION OF THE APPLICATION OF LIME TO RAW DOMESTIC WASTEWATER AS A MEANS OF ENHANCING THE EFFECTIVENESS OF PRIMARY TREATMENT, SPECIFICALLY TO REDUCE PHOSPHORUS LEVELS. LIME TREATMENT EFFECTED AN 80- TO 90-PERCENT REMOVAL OF TOTAL PHOSPHORUS, WITH GREATER THAN 97-PERCENT REMOVAL OF SOLUBLE, INORGANIC FORMS. LIME TREATMENT REMOVED 50 TO 70 PERCENT OF THE BOD, APPROXIMATELY 25 PERCENT OF THE TOTAL NITROGEN, AND DESTROYED 99.9 PERCENT OF THE COLIFORM BACTERIA. LIME DOSAGE WAS CONTROLLED BY PH. THE VOLUME OF SLUDGE PRODUCED WAS APPROXIMATELY 1 PERCENT OF THE VOLUME OF WASTEWATER TREATED. THE LIME TREATMENT EFFLUENTS HAD NITROGEN: PHOSPHORUS RATIOS OF 25:1 OR GREATER. PRELIMINARY STUDIES INDICATED THAT STABILIZATION PONDS SHOULD SERVE WELL IN POLISHING THE LIME-TREATED WASTEWATER, REMOVING 75 TO 80 PERCENT OF THE REMAINING PHOSPHORUS.

THE ROLE OF ALGAE IN THE BIOLOGICAL TREATMENT OF WATER (FRENCH),
CABRIDENC, R.; LEPAILLEUR, H.
IRCHA (FRANCE), MICROBIOLOGY SERVICE.
TERRES AND EAUX, REV INT DE L'HYDRAUL, VOL 22, NO 58, PP 12-18, JAN-MAR 1969. 7 P, 7 FIG, 1 TAB, 25 REF.
WATER PURIFICATION BY ALGAE.
05C
THE ROLE OF ALGAE, AS A DESALINATION AND PURIFICATION AGENT, WAS INVESTIGATED ON THE BASIS OF EARLIER PUBLICATIONS AND RECENT EXPERIMENTS CONDUCTED BY THE AUTHORS. THE STUDY SHOWS THAT OXYGEN LIBERATED IN THE COURSE OF PHOTOSYNTHESIS LEADS TO THE OXYGENATION OF AQUATIC MEDIA AND CONSIDERABLE REDUCTION OF PATHOGENIC GERMS. THE STUDY ALSO SHOWS THAT THERE IS COMPETITION BETWEEN ALGAE AND OTHER MICROORGANISMS; HOWEVER, IN THE PRESENT STATE OF KNOWLEDGE, THE PROBLEM OF INTERACTION DUE TO THE PRODUCTION BY ALGAE OF INHIBITING OR ACTIVATING SUBSTANCES IS STILL NOT CLEARLY UNDERSTOOD. THE DEGREE OF PURIFICATION OF WATER BY THE LAGOONING PROCESS, IN MANY CASES IS EQUIVALENT TO, OR GREATER THAN THAT OBTAINED BY OTHER BIOLOGICAL PROCESSES. (GABRIEL-USGS)

AQUACULTURE AS AN ALTERNATIVE WASTEWATER TREATMENT SYSTEM
CARPENTER, R. L.; COLEMAN, M. S.; JARMAN, R.
OKLAHOMA STATE DEPT. OF HEALTH, OKLAHOMA CITY.
IN: BIOLOGICAL CONTROL OF WATER POLLUTION. UNIV. OF PENNSYLVANIA PRESS, INC., PHILADELPHIA, PA.,
TOURBIER, J. AND PIERSON, R. W., JR. (EDITORS). 1976. P. 215-224, 5 FIG, 1 TAB, 26 REF.
FIELD 05D, 05E
THE USE OF AQUACULTURE TO UPGRADE WASTETREATMENT LAGOONS WHILE PRODUCING A VALUABLE BY PRODUCT IS BEING STUDIED IN A SIX-CELL, SERIALLY OPERATED, EXPERIMENTAL LAGOON SYSTEM. FISH WERE ALREADY PRESENT IN THE FIRST TWO CELLS RECEIVING CONVENTIONAL AERATED TREATMENT. THE FOUR NON-AERATED CELLS WERE VARIOUSLY STOCKED WITH CHANNEL CATFISH, GOLDEN SHINERS, FATHEAD MINNOWS, AND TILAPIA NILOTICA. THE SECONDARY TREATMENT STANDARD FOR 5-DAY BIOLOGICAL OXYGEN DEMAND WAS MET IN THE EFFLUENT FROM THE SECOND CELL; STANDARDS FOR SUSPENDED SOLIDS AND FECAL COLIFORMS WERE MET IN THE EFFLUENT OF THE FIFTH CELL. REMOVAL OF NITROGEN AND PHOSPHORUS WAS EXCELLENT. NO PATHOGENS WERE FOUND IN WASTE WATER BEYOND THE FIRST TWO CELLS NOR IN ANY OF THE 179 FISH SAMPLED. BIOMASS INCREASES WERE: 4 TO 163 LBS FOR TILAPIA NILOTICA; 600 TO 4000 LBS FOR CHANNEL CATFISH, 85 TO 535 LBS FOR GOLDEN SHINERS. WHEN OPERATED IN THE ABSENCE OF FISH, EFFLUENT QUALITY WAS LOWER AND THE SUSPENDED SOLIDS STANDARD WAS NOT MET.

SUPPLEMENTARY AERATION OF LAGOONS IN RIGOROUS CLIMATE AREAS.
CHANPLIN, R. L.
WYOMING UNIV., LARAMIE. DEPT. OF CIVIL ENGINEERING.
COPY AVAILABLE FROM GPO SUP DOC AS EP2.10:17050 DVO-10/71, $0.75; MICROFICHE FROM NTIS AS PB-208 204, $0.65.ENVIRONMENTAL PROTECTION AGENCY WATER POLLUTION CONTROL RESEARCH SERIES. OCTOBER 1971. 73 P. 24 FIG, 15 TAB, 7 REF. EPA PROGRAM 17050DVO--10/71.
05D
A PILOT SCALE FIELD INVESTIGATION OF THE EFFECTS OF SUPPLEMENTAL AERATION ON WASTE STABILIZATION LAGOONS WAS CONDUCTED AT LARAMIE, WYOMING, A LOW TEMPERATURE, HIGH ALTITUDE AREA. BOTH BATCH AND COMPLETE MIXED EXPERIMENTS WERE CONDUCTED USING CONSTANT AIR FLOWS. LOADING RATES, BOTH HYDRAULIC AND PROCESS, WERE VARIED FROM 160 LBS BOD5/ACRE/DAY (0.725 LBS/1000 FT3/DAY) TO 900 LBS BOD5/ACRE/DAY (4.06 LBS/1000 FT3/DAY). THE SUPPLEMENTAL AERATION PROVIDED BOTH AERATION AND MIXING, THEREBY INCREASING METABOLIC RATES. BOD REDUCTIONS VARIED FROM 72 TO 85% UNDER THREE DIFFERENT LOADINGS. AT TEMPERATURES OF LESS THAN 12 DEG C. LOADING OF 320 LBS/ACRE/DAY AND SECONDARY CELL OPERATION PRODUCED SIGNIFICANT ALGAL GROWTH EVEN AT TEMPERATURES AROUND 6 DEG C. NO SETTLEABLE SOLIDS WERE FOUND IN THE EFFLUENT FROM THE AERATED SYSTEM. SERIES OPERATION WAS DEMONSTRATED TO HAVE THE ADVANTAGES OF DAMPING VARIATIONS IN QUALITY PARAMETERS, PROVIDING FOR SHOCK LOADING, AND REDUCING COLIFORM COUNTS TO MINIMUM LEVELS. SHORTER DETENTION PERIODS ALSO TAKE GREATER ADVANTAGE OF THE WARMER INFLUENT TEMPERATURES IN ORDER TO SATISFY EASILY OXIDIZED ORGANIC MATERIAL. (LOWRY-TEXAS)

THE EFFECT OF LOW VOLUME AND HIGH VOLUME AERATION ON A HOG LAGOON.
CONVERSE, J. C.
NORTH DAKOTA STATE UNIV., FARGO. DEPT. OF AGRICULTURAL ENGINEERING.
MS THESIS, DEPARTMENT OF AGRICULTURAL ENGINEERING, MAY, 1966. 85 P., 44 FIG, 5 TAB, 19 REF.
TOTAL SOLIDS, VOLATILE ACIDS.
05D;05B;05A;05G
THE OBJECTIVES OF THE STUDY WERE TO EVALUATE THE EFFECTS OF LOW AND HIGH VOLUME SUBSURFACE AERATION ON A HOG LAGOON. LABORATORY TESTS WERE RUN ON LOW AND HIGH VOLUME SAMPLES AND CONTROL SAMPLES. AMONG FACTORS TESTED WERE: TEMPERATURE, PH, BOD, COD, TOTAL AND SUSPENDED SOLIDS, AMMONIA, NITRATE, NITRITE, ORP, VOLATILE ACIDS (HIGH VOLUME AERATION) AND DO (HIGH VOLUME AERATION). THE LOW VOLUME SUBSURFACE AERATION WHICH RANGED FROM 3.6 TO 3.8 CFM HAD NO MEASUREABLE EFFECT ON THE HOG LAGOON. FOR ALL OF THE TESTS CONDUCTED THERE APPEARED TO BE NO SIGNIFICANT DIFFERENCE BETWEEN THE MEANS OF THE VALUES OBTAINED IN THE TEST FOR THE AERATED AND THE CONTROL CELLS. DURING THE HIGH VOLUME AERATION PHASE, AN AVERAGE OF 2.28 MG/L OF DISSOLVED O2 WAS MAINTAINED IN THE AERATED CELL DURING THE TESTING PERIOD. ALL OF THE TESTS SHOWED A SIGNIFICANT DIFFERENCE OF THE MEANS, EXCEPT THE TOTAL SOLIDS, THE SUSPENDED SOLIDS, THE ORGANIC MATTER, AND THE AMMONIA. BASED ON THE ANALYSIS OF THIS EXPERIMENT, IT MAY BE BENEFICIAL TO AERATE A HOG LAGOON WITH AT LEAST ENOUGH AIR TO MAINTAIN SOME DISSOLVED OXYGEN IN THE LAGOON. THE AERATION WOULD ALLOW THE LAGOON TO BE LOADED AT A HIGHER RATE AND STILL MAINTAIN AEROBIC CONDITIONS. ECONOMICAL CONSIDERATIONS MAY MAKE THIS UNFEASIBLE. (CARTMELL-EAST CENTRAL)

ALGAL INFLUENCES ON DIEOFF RATES OF INDICATOR BACTERIA.
DAVIS, E. M.; GLOYNA, E. F.
TEXAS UNIV., AUSTIN. COLL. OF ENGINEERING.

PROCEEDINGS, INDUSTRIAL WASTE CONFERENCE, 25TH, MAY 5-7, 1970, PURDUE UNIVERSITY ENGINEERING EXTENSION SERIES NO. 137, P 266-273, 1 FIG, 4 TAB, 17 REF.
*AFTERGROWTH.
05D
DESTRUCTION OF COLIFORM BACTERIA IN WASTE TREATMENT FACILITIES HAS BEEN ATTRIBUTED TO A NUMBER OF PHYSICAL, BIOLOGICAL, AND CHEMICAL FACTORS. HOWEVER, SEVERAL SPECIES OF ALGAE APPEAR TO BE CAPABLE OF STIMULATING SPECIFIC COLIFORM ORGANISMS, THROUGH ALGAL METABOLIC EXUDATES WHICH ARE RELEASED DURING LOG GROWTH CONDITIONS AND FROM NUTRIENTS WHICH MAY BE RELEASED AFTER DEATH OF THE ALGAE. INVESTIGATIONS OF BEHAVIORAL PATTERNS OF SELECTED SPECIES OF ENTERIC BACTERIA WHEN IN THE PRESENCE OF SINGLE AXENIC CULTURES AND MIXED CULTURES OF SELECTED BLUE-GREEN AND GREEN ALGAE, AND INVESTIGATIONS OF THE BEHAVIOR OF ENTERIC BACTERIA IN THE PRESENCE OF ALGAE AND KNOWN QUANTITIES OF INDUSTRIAL WASTE WERE CONDUCTED. RESULTS INDICATED THAT ALCALIGENES FAECALIS, ENTEROBACTER AEROGENES, AND PROTEUS VULGARIS EXHIBITED ONLY LIMITED TENDENCIES FOR AFTERGROWTH, WHILE ESCHERICHIA COLI, PSEUDOMONAS, AND SERRATIA MARCESCENS SHOWED DISTINCT AFTERGROWTH CAPABILITIES IN ALL TEST ENVIRONMENTS USED. THESE INVESTIGATIONS DEMONSTRATED THAT THE ORGANISMS WHICH ARE USED AS POLLUTION INDICATORS MAY APPEAR IN NUMBERS SEEMING TO INDICATE DOMESTIC WASTEWATER POLLUTION WHEN NONE IS PRESENT. (LOWRY-TEXAS)

THE ROLE OF ALGAE IN DEGRADING DETERGENT SURFACE ACTIVE AGENTS.
DAVIS, ERNST M.; GLOYNA, E. F.
TEXAS UNIV., AUSTIN. DEPT. OF CIVIL ENGINEERING.
J WATER POLLUT CONTR FEDERATION, VOL 41, NO 8, PART 1, P 1494-1504, AUG 1969. 11 P, 4 FIG, 5 TAB, 21 REF. GRANT NO NSF-GU-1963.
*ABS, LAS.
05D
THE RATES OF DEGRADATION OF 3 TYPICAL NONIONIC AND 2 ANIONIC SURFACTANTS BY GREEN AND BLUE-GREEN ALGAE WERE EVALUATED. ADDITIONAL DATA WERE GATHERED FOR ORGANISMS OBTAINED FROM RAW WASTEWATER, ACTIVATED SLUDGE, AND WASTE STABILIZATION POND WATER. RESULTS SHOW THAT ALGAE CONTRIBUTE TO A SMALL EXTENT IN THE DEGRADATION OF COMMON HOUSEHOLD DETERGENTS. MOST DEGRADATION IS ATTRIBUTED TO BACTERIA OR OTHER ORGANISMS. ALGAE DID NOT DEGRADE ALKYL BENZENE SULFONATE WHILE BACTERIA DID (0.45 MG/1/DAY). THE OTHER ANIONIC SURFACTANT, LINEAR ALKYL SULFONATE, WAS DEGRADED IN SMALL AMOUNTS BY SOME OF THE DIFFERENT ALGAL FORMS (0.97 MG/1/DAY BY BACTERIA). NONIONIC DETERGENTS WERE MORE EASILY DEGRADED. (KNAPP-USGS)

DEVELOPMENTS IN THE TREATMENT OF SEWAGE FROM SMALL COMMUNITIES.
DEPARTMENT OF THE ENVIRONMENT, (U.K.). NOTES ON WATER POLLUTION, NO 60, P 1-4, MARCH, 1973. 14 REF.
*UNITED KINGDOM.
05D
THE TREATMENT OF SEWAGE FROM SMALL COMMUNITIES IS DISCUSSED AND RECENT DEVELOPMENTS ARE DESCRIBED. MANY PROBLEMS OF SMALL TREATMENT PLANTS RELATE DIRECTLY TO THE FACT THAT SMALL PLANTS CAN NORMALLY PROVIDE LITTLE SUPERVISION OR MAINTENANCE AND PRIVATELY OWNED PLANTS ARE ESPECIALLY LIABLE TO SERIOUS NEGLECT. BEFORE 1960, THERE WAS ESSENTIALLY ONLY A COMBINATION OF SEPTIC TANKS AND PERCOLATING FILTERS FOR TREATING SEWAGE FROM SMALL COMMUNITIES. DURING THE LAST DECADE A VARIETY OF MODIFIED ACTIVATED SLUDGE SYSTEMS HAS BEEN ACTIVELY DEVELOPED PARTICULARLY FOR SMALL SCALE USE. THREE FORMS OF PLANT HAVE EVOLVED: EXTENDED AERATION, CONTACT STABILIZATION, AND THE OXIDATION DITCH. PURIFICATION PLANTS USING ROTARY DISC BIOLOGICAL CONTACTORS HAVE RECENTLY BEEN INTRODUCED INTO THE UNITED KINGDOM. EXTENDED FILTRATION AND SUBMERGED BED AERATION PLANTS HAVE BEEN COMMERCIALLY DEVELOPED TO A SMALL SCALE AS SMALL PACKAGE PLANTS. THE MAIN DEVELOPMENTS IN EFFLUENT POLISHING FOR SMALL SYSTEMS HAVE BEEN WITH THE SIMPLEST SYSTEMS: GRASS PLOTS, UPWARD FLOW CLARIFIERS; AND SLOW SAND FILTERS. THE USE OF SEPARATE AEROBIC DIGESTION PLANTS TO STABILIZE RAW OR SEPTIC TANK SLUDGE AT CENTRAL COLLECTION WORKS HAS OVERCOME THE PROBLEM OF SLUDGE DISPOSAL. (MERRITT-FIRL)

THE AVAILABILITY OF DAPHNIA FOR WATER QUALITY IMPROVEMENT AND AS AN ANIMAL FOOD SOURCE.
DINGES, R.
TEXAS STATE DEPT. OF HEALTH, AUSTIN. DIV. OF WASTEWATER TECHNOLOGY AND SURVEILLANCE.
IN: WASTEWATER USE IN THE PRODUCTION OF FOOD AND FIBER -- PROCEEDINGS, MARCH 5-7, 1974, OKLAHOMA CITY, OKLAHOMA, P 142-161, 8 FIG, 18 REF.
THE INCORPORATION OF ADVANCED BIOLOGICAL METHODS INTO WASTE WATER TREATMENT SYSTEMS TO MAKE USE OF FERTILE EFFLUENTS FOR CULTIVATION OF BENEFICIAL ORGANISMS APPEARS FEASIBLE. THE USE OF DAPHNIA TO ATTAIN IMPROVEMENT OF WASTE WATER IS DISCUSSED. DAPHNIA ARE COMMON AQUATIC CRUSTACEANS ABOUT 1.8-INCH LONG WHICH FEED UPON ALGAE, BACTERIA, PROTOZOA, AND DEBRIS. ENVIRONMENTAL FACTORS AFFECTING THE GROWTH

OF DAPHNIA IN STABILIZATION PONDS ARE DISCUSSED, INCLUDING LIGHT (PHOTOPERIOD) AND WATER TEMPERATURE, DEPTH, PH, AND MINERAL CONTENT. DAPHNIA CULTURE IN WASTE WATERS REQUIRES PH CONTROL WITHIN A RANGE OF 7.0-7.5 AND SUFFICIENT MIXING FOR SUPPRESSION OF SOLUBLE SULFIDES. EQUIPMENT EXISTS FOR HARVESTING DAPHNIA. THE PRESENT MARKET FOR DAPHNIA IS LIMITED TO FISH FOOD, BUT AN EXCELLENT USE WOULD BE AS A PROTEIN ADDITIVE IN ANIMAL FEEDS. THE CLARIFIED EFFLUENT IS SUITABLE FOR BIOLOGICAL TREATMENT OR CHEMICAL-PHYSICAL METHODS FOR FURTHER NUTRIENT REMOVAL.

ECOLOGY OF DAPHNIA IN STABILIZATION PONDS.
DINGES, R.
TEXAS STATE DEPT. OF HEALTH, AUSTIN. DIV. OF WASTEWATER TECHNOLOGY AND SURVEILLANCE.
REPORT 1973. 41 FIG, 14 TAB, 69 REF, APPENDIX.
*DAPHNIA SIMILIS, DAPHNIA PULEX, MOINA, LEMNA.
05D
IT WAS OBSERVED THAT THE PRESENCE OF DAPHNIA RESULTED IN CLARIFIED WASTEWATER STABILIZATION POND EFFLUENT IN A FEW (6%) TEXAS LOCATIONS. THIS INVESTIGATION FOCUSED ON THE SUITABLE ENVIRONMENTAL CONDITIONS FOR DAPHNIA AND MOINA. THE TWO DAPHNIA SPECIES, D. SIMILIS AND D. PULEX, WERE ONLY PRESENT IN EXTRA DEEP PONDS. THE MANNER IN WHICH DAPHNIA SERVES TO STABILIZE AND CLARIFY WATER COULD INCLUDE DIGESTION PROCESSES, BY INCORPORATION OF ORGANICS INTO BIOMASS, AND SOME MATERIAL IS RENDERED INERT BY CONVERSION INTO CHITIN, THE MATERIAL OF WHICH DAPHNIA SHELLS ARE COMPOSED. A LIMITED MARKET FOR DAPHNIA EXISTS, BUT WOULD QUICKLY BE SATISFIED SHOULD MASS CULTURE IN WASTEWATER PROVE FEASIBLE AND OFFERS A REAL POSSIBILITY OF GAINING SIGNIFICANT FINANCIAL RETURNS FROM A WASTEWATER RESOURCE. A PILOT PLANT OPERATION INDICATED THAT SUCCESSFUL OPERATION REQUIRED PROVISION OF ADEQUATE MIXING-AERATION TO SUPPLY THE RESPIRATORY NEEDS AND ASSOCIATED ORGANISMS AND TO PRECLUDE EVOLUTION OF SOLUBLE SULFIDES FROM BENTHIC DEPOSITS AND TO CONTROL PH WITHIN A RANGE OF 7.0 - 7.5. DAPHNIA CULTURE (WHICH IS DESCRIBED) MAY BE FEASIBLE TO FURTHER IMPROVE EFFLUENTS FROM SECONDARY WASTEWATER TREATMENT PLANTS DUE TO ITS FEEDING HABITS ON ALGAE AND OTHER SUSPENDED ORGANIC MATERIAL. ITS LIFE CYCLE AND A PERTINENT LITERATURE REVIEW ARE INCLUDED. (AUEN-WISCONSIN)

INFILTRATION LAGOONS FOR TERTIARY TREATMENT OF STABILIZATION POND EFFLUENT.
DORNBUSH, J. N.
SOUTH DAKOTA STATE UNIV., BROOKINGS. DEPT. OF CIVIL ENGINEERING.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161, AS PB-259 473, IN PAPER COPY, IN MICROFICHE. SOUTH DAKOTA WATER RESOURCES RESEARCH INSTITUTE, TERMINATION REPORT, MARCH 1976. 38 P, 3 FIG, 4 TAB, 6 REF, 3 APPEND. OWRT A-044-SDAK(1), 14-31-0001-5042
*STABILIZATION PONDS, *INFILTRATION LAGOONS, AMMONIA NITROGEN, NITRATE NITROGEN.
05D:05B:04B
INFILTRATION LAGOONS WERE DESIGNED AND OPERATED TO MAKE MAXIMUM USE OF AN IN-PLACE SOIL SYSTEM TO PROVIDE ADVANCED TREATMENT OF STABILIZATION POND EFFLUENTS IN ORDER TO MEET FUTURE EFFLUENT STANDARDS. AFTER A THREE-MONTH PERIOD OF SUMMER OPERATION OF THE PILOT INFILTRATION-PERCOLATION BASINS, THE FOLLOWING PRELIMINARY CONCLUSIONS ARE SUGGESTED. PRELIMINARY LYSIMETER STUDIES DEMONSTRATED THAT A HIGH DEGREE OF TREATMENT WAS PROVIDED BY SOIL FILTRATION ALTHOUGH INFILTRATION RATES (ONE TO TWO INCHES PER DAY) IN THESE STUDIES WERE TOO LOW TO BE PRACTICAL FOR A FULL-SCALE OPERATION. SCARIFIED PILOT INFILTRATION-PERCOLATION BASINS, OPERATED WITH WEEKLY APPLICATIONS OF 10 AND 24 INCHES OF STABILIZATION POND EFFLUENT WERE ABLE TO MAINTAIN INFILTRATION RATES IN EXCESS OF 0.5 INCHES PER HOUR THROUGHOUT THE SUMMER. THE ORIGINAL COVER OF ALFALFA AND BROME GRASS MAINTAINED INFILTRATION RATES IN EXCESS OF ONE INCH PER HOUR AND CROP GROWTH THRIVED. INFILTRATION RATES WOULD NOT APPEAR TO BE A DETERRENT FACTOR IN THE DESIGN OF PRACTICAL, ECONOMICAL, INFILTRATION-PERCOLATION BASINS. AN EFFLUENT STANDARD WITH CONCENTRATIONS OF 10 MG/1 OF BOD5 AND SUSPENDED SOLIDS WOULD PROBABLY BE MET WITH A FULL-SCALE INFILTRATION- PERCOLATION BASIN DURING THE SUMMER IF IT WERE CONSTRUCTED TO PRECLUDE SHORT-CIRCUITING OF WASTEWATER TO THE GROUND WATER DRAINS. WITH WEEKLY APPLICATIONS OF WASTEWATER THE OXIDATION OF AMMONIA NITROGEN TO NITRATES WAS INDICATED. AMMONIA NITROGEN REDUCTIONS WERE ACCOMPLISHED AND THE EFFLUENT FROM THE INFILTRATION-PERCOLATION BASINS WOULD HAVE MET A 1.5 MG/1 AMMONIA NITROGEN STANDARD ABOUT 50 PERCENT OF THE TIME. NITRATE NITROGEN CONCENTRATION EXCESS OF 10 MG/1 MIGHT BE EXPECTED TO REACH THE GROUND WATER FROM INFILTRATION-PERCOLATION BASINS OPERATED ON A WEEKY CYCLE OF WASTEWATER APPLICATION IF AN ADEQUATE UNDERDRAIN SYSTEM WERE NOT INSTALLED. ABOUT 50 PERCENT OF THE PHOSPHORUS APPLIED WITH THE WASTEWATER WAS REMOVED BUT EFFLUENT CONCENTRATIONS FREQUENTLY EXCEEDED 1.0 MG/1. LEACHING OF SOLUBLE SALTS FROM THE SOIL IS INDICATED BY THE HIGHER CONDUCTIVITY OF THE EFFLUENT FROM THE PILOT BASINS.

AERATED LAGOONS FOR POTATO PROCESSING WASTES.
DOSTAL, KENNETH A.
FEDERAL WATER QUALITY ADMINISTRATION, CORVALLIS, OREG. PACIFIC NORTHWEST WATER LAB.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 243-249, 2 FIG, 6 TAB, 6 REF.
*AERATED LAGOONS, SUSPENDED SOLIDS, *POTATO WASTES.
05D
PILOT-SCALE PLANTS WERE OPERATED FOR TWO NINE MONTH PROCESSING SEASONS ON POTATO WASTES. 4200 GALLONS OF FRESH WATER WERE USED TO PROCESS EACH TON OF POTATO WASTES, PRODUCING 90 LBS OF BOD, 210 LBS OF COD, 110 LBS OF SUSPENDED SOLIDS, .6 LBS OF TOTAL PHOSPHATES AS P, AND 3.5 LBS OF TOTAL NITROGEN AS N ON THE NINE MONTH AVERAGE. SCHEMATIC DIAGRAMS OF THE PILOT PLANTS WERE CONSTRUCTED AND ARE PRESENTED. FROM THE PRECEDING STUDIES, THE FOLLOWING CONCLUSIONS WERE OBTAINED: (1) EITHER AN AEROBIC LAGOON OR AN ANAEROBIC-AEROBIC LAGOON SERIES IN CONJUNCTION WITH PRIMARY SEDIMENTATION CAN ACHIEVE AS HIGH AS 90% BOD REDUCTION, (2) BOTH SYSTEMS ARE ECONOMICALLY FEASIBLE, THE CHOICE DEPENDENT UPON LOCAL CONDITIONS, (3) CONSTANTS DERIVED FROM THIS STUDY WERE USED TO FORMULATE MODELS TO ADEQUATELY DESCRIBE BOD REDUCTION ACROSS THE PONDS, (4) CHEMICAL ADDITIONS WERE NOT REQUIRED FOR EITHER PH CONTROL OR INORGANIC NUTRIENT ADJUSTMENT; AND (5) SOME METHOD OF SUSPENDED SOLIDS REMOVAL WILL USUALLY BE REQUIRED. SEVERAL FULL SCALE INSTALLATIONS HAVE RECENTLY BEEN PLACED IN SERVICE, BUT DATA IS NOT YET AVAILABLE.

PILOT PLANT STUDIES ON SECONDARY TREATMENT OF POTATO PROCESSING WASTES.
DOSTAL, KENNETH A.
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CORVALLIS, OREG. PACIFIC NORTHWEST WATER LAB.
IN: POTATO WASTE TREATMENT, PROCEEDINGS OF A SYMPOSIUM SPONSORED BY FWPCA AND IDAHO UNIVERSITY, MARCH 1968, P 27-41, 3 FIG, 5 TAB, 3 REF.
*SUSPENDED SOLIDS.
05D
TWO PILOT SCALE LAGOON SYSTEMS WERE DESIGNED AND CONSTRUCTED. THE FIRST BEING AN ANAEROBIC LAGOON FOLLOWED BY A SURFACE AERATED LAGOON, AND THE SECOND CONSISTING SOLELY OF A SURFACE AERATED LAGOON. TESTS WERE PERFORMED ON BOTH SYSTEMS TO DETERMINE THE FEASIBILITY OF TREATING POTATO WASTES BY SUCH METHODS. PRELIMINARY RESULTS HAVE INDICATED THAT: (1) BOD5 REMOVALS IN EXCESS OF 90% CAN BE ACHIEVED WITH PRIMARY CLARIFICATION PLUS ANAEROBIC-AEROBIC LAGOONS IN SERIES; (2) CONTENTS OF THE ANAEROBIC LAGOON MUST BE MIXED FOR PROPER SYSTEM OPERATION; (3) COVERING THE ANAEROBIC LAGOON HELPS TO CONTROL ODORS AND CONSERVE HEAT; AND (4) SECONDARY CLARIFICATION MUST FOLLOW THE AEROBIC LAGOON FOR SOLIDS REMOVAL. PRELIMINARY COST ESTIMATES WERE FORMULATED FOR BOTH SYSTEMS PROVIDING 84% REMOVAL OF THE 1700 MG/L INFLUENT BOD (270 MG/L BOD IN EFFLUENT). ESTIMATES FOR AEROBIC POND TREATMENT ALONE WERE $48,000/YEAR/MGD TREATED, WHILE ESTIMATES FOR THE ANAEROBIC-AEROBIC POND SERIES WERE $39,000/YEAR/MGD TREATED, BOTH BASED ON A 24 HR/DAY, 300 DAY/YEAR OPERATION.

SECONDARY TREATMENT OF POTATO PROCESSING WASTES.
DOSTAL, KENNETH A.
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CORVALLIS, OREG. PACIFIC NORTHWEST WATER LAB.
COPY AVAILABLE FROM GPO, SUP DOC, WASH DC, $0.65; WATER POLLUTION CONTROL RESEARCH SERIES, JUL 1969, 58 P, 10 FIG, 10 TAB, 14 REF, EPA PROGRAM 12060--07/69.
SUSPENDED SOLIDS, *POTATO PROCESSING WASTES.
05D
ANNUAL U.S. POTATO PRODUCTION HAS RISEN FROM LESS THAN 10 MILLION TONS IN 1951 TO MORE THAN 15 MILLION TONS IN 1966. FROM 1955 THROUGH 1966, ANNUAL PRODUCTION OF FROZEN SPECIALITY PRODUCTS ROSE FROM 129 MILLION LBS TO 1460 MILLION LBS. THIS PHENOMENAL GROWTH HAS PRODUCED INCREASING EFFLUENT PROBLEMS. A PILOT SCALE STUDY WAS CONDUCTED FROM OCTOBER 1966 THROUGH JUNE 1968 ON THREE LAGOONS. SEVERAL CONFIGURATIONS WERE EXPERIMENTED WITH, BUT THE TWO SELECTED FOR COMPARISON WERE: (1) A STRICTLY AEROBIC LAGOON HAVING A 10 HP AERATOR; AND (2) A SERIES ANAEROBIC-AEROBIC LAGOON SYSTEM WITH THE AEROBIC LAGOON, HAVING A 5 HP AERATOR. ALL THREE PONDS WERE APPROXIMATELY 40 FT X 40 FT X 10 FT DEEP. THE ANAEROBIC POND WAS COVERED WITH 3 INCH THICK STYROFOAM PADS TO CONTROL ODORS AND PREVENT UNNECESSARY HEAT LOSS. IT WAS DETERMINED THAT PRIMARY CLARIFICATION AND EITHER THE AEROBIC LAGOON OR THE ANAEROBIC-AEROBIC LAGOON SERIES COULD ACHIEVE IN EXCESS OF 90% BOD REMOVALS FROM THE POTATO WASTES. THE BOD REDUCTION ACROSS THE PONDS WAS ADEQUATELY MODELED USING AVAILABLE MODELS, AND SUFFICIENT DATA WAS OBTAINED TO ESTABLISH VALUES FOR THE NECESSARY CONSTANTS. NO CHEMICAL ADDITIONS FOR EITHER NUTRIENT BALANCE OR PH CONTROL WERE REQUIRED, BUT USE OF A SECONDARY CLARIFIER FOR SUSPENDED SOLIDS REMOVAL WAS RECOMMENDED. (LOWRY-TEXAS)

INVESTIGATION OF AN ANAERODIC-AEROBIC LAGOON SYSTEM TREATING POTATO PROCESSING WASTES
DORNDUSH, J. N.; ROLLAG, D. A.; TRYGSTAD, W. J.
SOUTH DAKOTA STATE UNIV., BROOKINGS. DEPT. OF CIVIL ENGINEERING.
IN: PROCEEDINGS OF THE SIXTH NATIONAL SYMPOSIUM ON FOOD PROCESSING WASTES, APRIL 9-11, 1975. 1976. P 3-21. 3 FIG. 3 TAB. 5 REF. REPORT EPA-600/2-76-224.
FIELD 05D
THE TREATMENT EFFICIENCY OF THE POTATO PROCESSING WASTE TREATMENT UNITS AT MIDWEST FOODS CORPORATION IN CLARK, SOUTH DAKOTA, WAS INVESTIGATED PRIOR TO THE 1973-1974 PROCESSING SEASON. THE SYSTEM INCLUDED A 100,000 CU FT ANAEROBIC LAGOON, FOLOWED BY A 404,000 CU FT AEROBIC LAGOON. THE AEROBIC CONDITIONS IN THE AERATED LAGOON AND STABILIZATION POND INDICATED THESE UNITS HAD RECOVERED FROM PREVIOUS OVERLOADING. THE ADOPTION OF DRY-CAUSTIC PEELING AND OTHER WATER CONSERVATION PRACTICES REDUCED WATER USAGE FROM 3500 GAL PER TON OF RAW POTATOES TO APPROXIMATELY 813 GAL. THE ANAEROBIC LAGOON REMOVED 74% OF THE BOD AND 78% OF THE SUSPENDED SOLIDS (SS), DESPITE AN AVERAGE BOD LOADING OF 45.5 LBS/1000 CU FT/DAY, OVER THREE TIMES HIGHER THAN THE DESIGN VALUE. THE ANAEROBIC LAGOON'S STYROFOAM-STRAW COVER MAINTAINED ADEQUATE TEMPERATURES IN THE LAGOON AND HELPED CONTROL ODORS. THE BOD:N:P RATIOS INDICATED THAT THE USE OF AN ANAEROBIC LAGOON PRIOR TO AEROBIC TREATMENT CONSERVED INORGANIC NUTRIENTS. THE AERATED LAGOON, OPERATED WELL WITHIN THE BOD LOADING RANGE, REMOVED 82% OF BOD AND 68% OF SS. THE STABILIZATION POND, OPERATING AT ABOUT 50% OF ITS DESIGN BOD LOADING, REMOVED 77% OF BOD AND 79% OF SS. THE TREATMENT SYSTEM AS A WHOLE REMOVED 99% OF BOD, 98.5% OF SS, AND 96.3% OF COD. SILT WHICH BUILDS UP IN THE ANAEROBIC LAGOON AT A RATE OF 40.5 CU.FT/OPERATING DAY COULD EVENTUALLY DECREASE ITS CAPACITY.

MUNICIPAL WASTEWATER AQUACULTURE
DUFFER, W. R.; MOYER, J. E.
ROBERT S. KERR ENVIRONMENTAL RESEARCH LAB., ADA, OK. WASTEWATER MANAGEMENT BRANCH.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-284 352, IN PAPER COPY, IN MICROFICHE. EPA-600/2-78-110, JUNE 1978. 46 P, 9 TAB, 71 REF.
FIELD 05D, 05C
LITERATURE OF JUNE 1977 ON THE DEVELOPMENTAL STATUS OF AQUACULTURE AS AN ALTERNATIVE METHOD FOR TREATMENT AND REUSE OF MUNICIPAL WASTEWATER WAS REVIEWED. CURRENT TECHNOLOGY IS NOT ADEQUATE FOR DESIGNING OPERATIONAL AQUACULTURAL TREATMENT SYSTEMS, BUT SEVERAL TYPES OF ORGANISMS HOLD CONSIDERABLE POTENTIAL. ONLY NEW OR DEVELOPMENTAL PROCESSES WERE CONSIDERED, AND CONVENTIONAL OR ADVANCED APPLICATION PROCESSES WERE EXCLUDED. SYSTEMS EXAMINED INCLUDED NATURAL WETLANDS, ARTIFICIAL WETLANDS, MACROPHYTES, INVERTEBRATES, FISH, AND INTEGRATED OR FOOD CHAIN UNITS. MAJOR EMPHASIS WAS GIVEN TO THE REDUCTION OR FATE OF SUCH POLLUTANTS AS ORGANICS, SOLIDS, NUTRIENTS, HEAVY METALS, RESIDUAL HYDROCARBONS, AND POTENTIALLY PATHOGENIC ORGANISMS. ECONOMIC ASSESSMENTS OF TREATMENT AND PRODUCTION RATES FOR ORGANISMS ARE PROVIDED FOR SEVERAL TYPES OF AQUACULTURAL PROCESSES, AND AREAS HAVING HIGH POTENTIAL FOR FURTHER RESEARCH AND DEVELOPMENT ARE IDENTIFIED. CONCLUSIONS: (1) WATER HYACINTH, SEAWEED, AND MIDGE LARVAE SHOW PARTICULAR PROMISE; (2) FRESHWATER SYSTEMS HAVE A DISTINCT ADVANTAGE OVER MARINE SYSTEMS AS MUCH SMALLER VOLUME OF WATER IS REQUIRED; (3) USE OF AQUACULTURE FOR PRODUCING HUMAN FOOD, WHICH HAS BEEN THE MAJOR FOCUS OF RESEARCH TO DATE (WITH LITTLE DEVOTED TO WASTEWATER TREATMENT OR REUSE), IS HAMPERED IN WASTEWATER TREATMENT BY DISEASE TRANSMISSION AND SOCIAL ACCEPTANCE, AND OTHER PRODUCTS SHOULD BE INVESTIGATED; (4) ECONOMIC RETURN ON SUCH PRODUCTS MAY BE SMALL, BUT ENERGY SAVINGS MAY BE REALIZED; AND (5) AQUACULTURE MAY BE MOST APPLICABLE IN COMBINATION WITH OTHER TREATMENT METHODS. (LYNCH-WISCONSIN)

LAGOON EFFLUENT SOLIDS CONTROL BY BIOLOGICAL HARVESTING,
DUFFER, W. R.
ROBERT S. KERR ENVIRONMENTAL RESEARCH LAB., ADA, OKLA.
IN: UPGRADING WASTEWATER STABILIZATION PONDS TO MEET NEW DISCHARGE STANDARDS, AUGUST 21-23, 1974, LOGAN, UTAH, UTAH STATE UNIVERSITY, P 187-190. 14 REF.
TILAPIA NILOTICA, *BIOLOGICAL HARVESTING, BIVALVE MOLLUSCS.
05D
AEROBIC BACTERIA AND ALGAE ARE RESPONSIBLE FOR THE STABILIZATION OF ORGANIC WASTES IN LAGOONS. RESEARCH HAS CONCENTRATED MOSTLY ON IMPROVING PRODUCTION OF ALGAE AND PHYTOPLANKTON, RESULTING IN INCREASED SUSPENDED SOLIDS CONCENTRATIONS. INSTEAD OF TRYING TO INCREASE THE BACTERIA POPULATION TO CONSUME THE ALGAE. ACCOMPLISHMENTS OF SEVERAL STUDIES ORIENTED TOWARD REMOVAL OF PHYTOPLANKTON BY OTHER AQUATIC ORGANISMS ARE REVIEWED. PROBLEMS ASSOCIATED WITH THIS BIOLOGICAL HARVESTING ARE DISCUSSED, AND RESEARCH AREAS ARE SUGGESTED. THREE TYPES OF ORGANISMS HAVE BEEN INVESTIGATED: ZOOPLANKTON, BIVALVE MOLLUSKS, AND FISH. EXPERIMENTS THAT WERE PERFORMED USING THE ZOOPLANKTON DAPHNIA INDICATED GOOD SUSPENDED SOLIDS REMOVAL. SINCE THE OCCURRENCE OF THIS ORGANISM IS VERY UNCOMMON IN WASTE WATER PONDS, CULTURE PONDS REQUIRING RIGID CONTROL AND EXTENSIVE MANAGEMENT MUST BE CONSIDERED. EXPERIMENTS PERFORMED WITH BIVALVE

MOLLUSKS HAVE SHOWN ALGAE REMOVALS OF UP TO 85%. THE USE OF CULTURED FISH, MOSTLY CARP, IN CHINA HAS BEEN PRACTICED FOR CENTURIES AS A METHOD OF PURIFYING WATERS. VARIOUS EFFORTS IN THE UNITED STATES INCLUDED THE USE OF CARP, FATHEAD MINNOWS, FINGERLING CHANNEL CATFISH, GOLDEN SHINER MINNOWS, AND TALAPIA NILOTICA. THE BEST APPROACH TO DATE FOR THE REMOVAL OF SOLIDS IN OXIDATION PONDS HAS BEEN THE FOOD CHAIN CONCEPT. LARGER SCALE SYSTEMS MUST BE EXPERIMENTED WITH. ADDITIONAL RESEARCH EFFORTS SHOULD INCLUDE: EXTENT OF SELECTIVE SOLIDS UPTAKE; EXAMINATION OF A GREATER NUMBER OF SPECIES; TAKING A MULTI-SPECIES APPROACH; STUDY OF SEASONAL ASPECTS; PRODUCTIVITY OF CULTURE SYSTEMS; AND THE POTENTIAL FOR PROBLEMS.

MECHANISMS OF ANAEROBIC WASTE TREATMENT.
DUGAN, GORDON L.; OSWALD, WILLIAM J.
CALIFORNIA UNIV., BERKELEY.
IN: POTATO WASTE TREATMENT, PROCEEDINGS OF A SYMPOSIUM SPONSORED BY FWPCA AND IDAHO UNIVERSITY, MARCH 1968. P 5-17, 5 FIG, 1 TAB.
*DETENTION TIME.
C5D
ANAEROBIC TREATMENT OF VARIOUS MUNICIPAL AND INDUSTRIAL WASTES IS PRACTICED MAINLY IN ANAEROBIC DIGESTERS, FACULTATIVE LAGOONS, AND ANAEROBIC LAGOONS. DECOMPOSITION TAKES PLACE IN TWO PHASES, DURING ANAEROBIC DIGESTION. THE FIRST, OR 'ACID' PHASE INVOLVES THE BREAKDOWN OF SETTLED SLUDGE TO ORGANIC VOLATILE ACIDS AND ENERGY, AND THE SECOND OR 'GAS' PHASE CONSISTS OF THE CONVERSION OF THE ORGANIC VOLATILE ACIDS TO CO2, CH4, H2, N2, AND MINOR AMOUNTS OF OTHER GASES. DIGESTION TEMPERATURES USUALLY LIE SOMEWHERE BETWEEN 15 AND 35 DEG C, WITH GAS COLLECTION AND RE-USE AS A HEAT SOURCE BEING PRACTICED IN CONVENTIONAL ANAEROBIC DIGESTION. DIGESTER LOADING IS EXPRESSED AS LBS VOLATILE SOLIDS/FT3/DAY AND RANGE FROM 0.08 TO 0.1. FACULTATIVE PONDS ARE INITIALLY LOADED AT FROM 20 TO 50 LBS BOD5/ACRE/DAY. BUT ONCE ESTABLISHED THEY MAY BE LOADED AS HIGH AS 1000 LBS BOD5/ACRE/DAY. DETENTION TIMES OF 3, 30, 90 AND 8-10 DAYS ARE COMMON FOR AEROBIC PONDS, CONVENTIONAL DIGESTION, FACULTATIVE PONDS, AND ANAEROBIC PONDS RESPECTIVELY, WITH EFFICIENCIES FOR SAME BEING 80% FOR AEROBIC PONDS, 85 TO 95% FOR FACULTATIVE PONDS, AND 70% FOR ANAEROBIC PONDS. LACK OF CONTROL OF ODOR PROBLEMS HAS HINDERED APPLICATION OF ANAEROBIC PONDS, AND RESEARCH WORK TO DEVELOP SUCH CONTROLS IS NEEDED.

RELATIONSHIP OF CHLOROPHYLL A TO ALGAL COUNT AND CLASSIFICATION IN OXIDATION PONDS.
DUST, JOSEPH V.; SHINDALA, ADAM
LAMAR STATE COLL. OF TECHNOLOGY, BEAUMONT, TEX.
JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 42, NO 7, P 1362-1369, JULY 1970. 7 FIG, 7 REF.
*ENUMERATION, ANACYSTIS.
C5D
A STUDY WAS CONDUCTED AIMED AT OBTAINING A QUANTITATIVE COMPARISON OF CHLOROPHYLL A WITH THE TOTAL NUMBER OF ORGANISMS IN THE TRINITY RIVER AUTHORITY WASTE WATER TREATMENT PLANT AS WELL AS A COMPARISON WITH THE VARIOUS SPECIES OF ALGAE EXISTING FROM TIME TO TIME IN THESE OXIDATION PONDS. THE LITERATURE INDICATES THAT THE ANALYTICAL DETERMINATION OF CHLOROPHYLL PIGMENTS CAN BE ACCOMPLISHED SPECTROPHOTOMETRICALLY WITH THE FOLLOWING EQUATION: CHLOROPHYLL A IN MG/L = (14.3) D665, WHERE D665 IS THE LIGHT ABSORBANCE AT A WAVE LENGTH OF 665 MILLIMICRONS AND A SLIT WIDTH OF 0.3 MM. EIGHT MAJOR TYPES OF ALGAE WERE FOUND IN SIGNIFICANT NUMBERS: DOCYSTIS, ANACYSTIS, CHLORELLA, DESMIDS, SCENEDESMUS, COELASTRUM, ZYGNEMA, AND CLOSTERIUM. THE ANACYSTIS ORGANISM WAS FOUND MORE FREQUENTLY AND IN GREATER NUMBERS THAN ANY OTHER ORGANISM. THE AVERAGE WEEKLY COUNT OF ANACYSTIS VARIED FROM ABOUT 1 TO 4 MILLION PER ML DURING THE FIRST 15 WEEKS OF THE STUDY COMPRISING THE SUMMER AND EARLY FALL MONTHS OF THE YEAR. CHLORELLA AND SCENEDESMUS WERE THE PREDOMINANT ORGANISMS DURING THE LATE FALL, WINTER, AND EARLY SPRING MONTHS, WITH CELL COUNTS OF 10,000 TO 100,000 CELLS/ML. A RELATIONSHIP BETWEEN CHLOROPHYLL A AND TOTAL ALGAL COUNT WAS NOT FOUND. HOWEVER, A DEFINITE RELATIONSHIP EXISTED BETWEEN THE AMOUNT OF CHLOROPHYLL A AND THE NUMBER OF ANACYSTIS ORGANISMS PRESENT. A SIMILAR RELATIONSHIP WAS FOUND WITH ZYGNEMA.

THE USE OF AERO-HYDRAULIC GUNS IN THE BIOLOGICAL TREATMENT OF ORGANIC WASTES.
DUTTON, C. S.; FISHER, C. P.
PROCTOR AND REDFERN, TORONTO (ONTARIO).
PROCEEDINGS, INDUSTRIAL WASTE CONFERENCE, 21, VOL L, NO 2, MARCH 1966. P 403-423, 7 FIG.
AERO-HYDRAULIC GUN, ALLISTON(ONTARIO).
C5D
THE AERATED LAGOON TREATMENT OF ORGANIC WASTES IS AN ECONOMICAL AND INCREASINGLY POPULAR PROCESS. HOWEVER, THE DEGREE OF TREATMENT HAS BEEN LIMITED BY THE NATURE OF DEVICES AVAILABLE FOR ACCOMPLISHING OXYGENATION. RECENT EXPERIMENTS UTILIZED AERO-HYDRAULIC GUNS IN SIMPLE AERATED LAGOONS FOR TREATMENT OF

ORGANIC WASTES. THE GUNS CONSISTED OF A POLYETHYLENE STACK PIPE, BUBBLE GENERATOR, AND AN AIR SUPPLY THAT PERIODICALLY RELEASED NUMEROUS SMALL BUBBLES FROM THE LAGOON BOTTOM. THE RESULTING FLOW PATTERN OF LIQUID FROM THE LAGOON BOTTOM INVOLVED A STRONG RADIAL CURRENT AT THE SURFACE. OXYGENATION CAPACITY OF THE GUNS WERE DERIVED IN A SERIES OF CURVES THAT PLOTTED LBS O2/HR AGAINST FREE AIR CONSUMPTION. CORRECTION FACTORS PERMITTED APPLICATION OF THE CURVES TO ACTUAL DESIGNS. A GUN CAN ALSO FUNCTION AS A POSITIVE SLUDGE RETURN PUMP BY SEALING UP ONE OF THE PORTS AND CONNECTING A SUCTION PIPE. AT A POTATO WASTE TREATMENT FACILITY IN ALLISTON, ONTARIO, SOME 790,000 GPD OF POTATO WASTE WAS DISCHARGED DAILY ALONG WITH A LOAD OF 5,000 LBS BOD AND A LIKE AMOUNT OF SUSPENDED SOLIDS. RECOMMENDATIONS FOR THIS FACILITY WERE: (1) TWO CONVENTIONAL SETTLING BASINS, EACH 24 FT SQUARE EQUIPPED WITH A SLUDGE SCRAPER, (2) A SIMPLE AERATED LAGOON EQUIPPED WITH 127 GUNS, AND (3) TWO ALGAE LAGOONS. DR. C. P. FISHER STUDIED THE SYSTEM AND FOUND BOD REMOVAL ACHIEVED BY THE AERATED LAGOON WAS APPROXIMATELY 90% WITH LITTLE OR NO MEASURABLE RESIDUAL DISSOLVED OXYGEN. THERE WAS NO DOUBT THAT THE THOROUGH MIXING PRODUCED BY THE GUNS WAS RESPONSIBLE TO A GREATER OR LESSER DEGREE FOR THE HIGH REMOVALS. OTHER STUDIES WERE CONDUCTED ON POULTRY AND FRUIT CANNING WASTES. (BURDETTE-TEXAS)

MANURE LAGOONS.....DESIGN CRITERIA AND MANAGEMENT.
EBY, HARRY J.
MARYLAND UNIV., COLLEGE PARK, DEPT. OF AGRICULTURAL ENGINEERING.
ASAE PAPER NO 61-935. AGRICULTURAL ENGINEERING JOURNAL, VOL 43, P 698-701, 714-715, DEC 1962. 6 FIG, 1 TAB, 19 REF.
*SITE SELECTION, LOADING.
050
CRITERIA TO BE CONSIDERED WHEN DESIGNING A LAGOON FOR TREATMENT OF WASTES PRODUCED BY ANIMALS IN CONFINEMENT IS DISCUSSED. IT MENTIONS SITUATIONS WHERE LAGOONS WOULD NOT BE FEASIBLE. SEVEN CRITERIA FOR SITE SELECTION ARE GIVEN. THE PHYSICAL, CHEMICAL AND BIOLOGICAL FACTORS DISCUSSED INCLUDE TEMPERATURE, LIGHT, SPECIFIC GRAVITY, MIXING, NUTRITIONAL EFFECTS, PH EFFECTS, TOXIC EFFECTS, AND INTERRELATIONSHIP OF BIOLOGICAL SPECIES. ALSO MENTIONED IS THE ALGAL-BACTERIAL RELATIONSHIP. DESIGN FACTORS FOR SIZE AND VOLUME ARE GIVEN. THE ARTICLE CONCLUDES WITH MANAGEMENT PROBLEMS ENCOUNTERED SUCH AS FLOATING DEBRIS, OVERLOADING, INTERMITTENT LOADING, AQUATIC WEEDS AND SLUDGE BUILD-UP. (PARKER-ICWA

PERIODICITY OF THE BLUE-GREEN ALGAE AND THEIR EFFECT ON THE EFFICIENCY OF MANURE-DISPOSAL LAGOONS.
EBY, H. J.; SINGH, V. P.
AGRICULTURAL RESEARCH SERVICE, WASHINGTON, D.C. AGRICULTURAL ENGINEERING RESEARCH DIV.
FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C. 20402. PRICE $0.15. PRODUCTION RESEARCH REPORT NO 142, APRIL, 1972. 8 P, 2 FIG, 2 TAB.
*INDIA, WASTE DISPOSAL LAGOONS, SEASONAL GROWTH.
050;05C;04A
THIS RESEARCH PROVIDED A STARTING POINT FOR EXPANDING FEED PRODUCTION AND AIDING IN THE BIOLOGICAL PURIFICATION OF WASTE WATER. RESEARCH IN INDIA REVEALED THAT BLUE-GREEN ALGAE HAVE SELF-LIMITING TENDENCIES AND MAY BE USED ADVANTAGEOUSLY. SINCE GROWTH PERIODS IN THE SPECIES VARY, SCIENTISTS MIGHT POSSIBLY ANTICIPATE EACH SPECIE'S POPULATION PEAKS THEREBY CONTROLLING ALGAE GROWTH. HARVESTING OF ALGAE SERVES TWO PURPOSES: (1) TO REMOVE ORGANIC MATTER THUS PREVENTING IT FROM BECOMING A POLLUTANT, AND (2) TO SERVE AS POTENTIAL LIVESTOCK AND POULTRY FEED. (FRANTZ-EAST CENTRAL)

DISPOSAL ALTERNATIVES FOR INTERMITTENT SAND FILTER SCRAPINGS UTILIZATION AND SAND RECOVERY.
ELLIOTT, J. T.; FILIP, D. S.; REYNOLDS, J. H.
UTAH CENTER FOR WATER RESOURCES RESEARCH, LOGAN.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-257 492, $4.50 IN PAPER COPY, $3.00 IN MICROFICHE. UTAH WATER RESEARCH LABORATORY PUBLICATION, PRJER033-1, JUNE 1976. 54 P, 40 FIG, 42 TAB, 41 REF, 3 APPEND. OWRT A-033-UTAH(1), 14-34-0001-6046.
LOGAN(UTAH), *SAND FILTERS, *LAND APPLICATION, SOIL CONDITIONERS.
5D;5E;6C
A THREE PHASE STUDY IS USED TO DEVELOP DISPOSAL ALTERNATIVES AND COST ANALYSIS FOR ALGAE LADEN SAND SCRAPINGS REMOVED FROM INTERMITTENT SAND FILTERS USED TO POLISH WASTEWATER LAGOON EFFLUENT. PHASE I, IRRIGATION TECHNIQUE, EXPLORES THE FEASIBILITY OF SUPPLYING SUFFICIENT WATER TO SAND SCRAPINGS TO LEACH OUT ENTRAPPED MATERIAL. DETAILS OF REMOVAL WITH AMOUNT OF WATER APPLIED ARE PRESENTED. PHASE II, SOIL APPLICATION, TESTS WITH LYSIMETERS SOIL RESPONSE TO APPLICATION OF THE ALGAE LADEN SAND MATERIAL. PHYSICAL AND CHEMICAL PARAMETERS ARE NOT MARKEDLY ALTERED WHERE ALGAE LADEN SAND IS APPLIED TO THE SOIL SURFACE. PHASE III, PLANT BIOASSAYS, GREW TALL FESCUE ON LYSIMETERS WHICH HAD ALGAE LADEN SAND

SCRAPINGS APPLIED AND COMPARED THIS GROWTH RESPONSE WITH LYSIMETERS HAVING NO ADDITIVES TO A CLAY SOIL AND LYSIMETERS HAVING AMMONIUM NITRATE ADDED AS FERTILIZER. RESULTS INDICATE THAT ALL THREE DISPOSAL ALTERNATIVES ARE VIABLE RECOURSES FOR SEWAGE SAND FILTER SAND DEPOSITION AND UTILIZATION. COST ANALYSIS INDICATES THAT AN IRRIGATION TECHNIQUE MAY BE LESS EXPENSIVE.

STABILIZATION OF DAIRY WASTES BY ALGAL-BACTERIAL SYMBIOSIS IN OXIDATION PONDS.
EL-SHARKAWI, F. M.; NOAWAD, S. K.
ALEXANDRIA UNIV. (EGYPT). HIGH INST. OF PUBLIC HEALTH.
JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 42, NO 1, P 115-125, JANUARY 1970. 4 FIG, 5 TAB, 17 REF.
*ALEXANDRIA(EGYPT), PANDORINA, SOLUBLE ORGANIC SOLIDS.
05D
A PILOT-PLANT STUDY OF BOD REDUCTION OF MILK PROCESSING WASTES IS REPORTED. A SYNTHETIC DAIRY WASTE OF 750 MG/L BOD WAS FED CONTINUOUSLY TO RECTANGULAR CONCRETE BASINS WITH SLOPING SIDES TO MINIMIZE SLUDGING. THE DETENTION PERIOD WAS 10 DAYS. AN INFLUENT PH OF 9.8 WAS MAINTAINED TO KEEP THE PH AT A LEVEL CONDUCIVE TO ALGAL GROWTH. TANK DEPTH WAS IMPORTANT IN MAINTAINING BALANCE BETWEEN THE ALGAL AND BACTERIAL FRACTIONS OF THE SYSTEM. THE MICROFLORA SHOWED PLASTICITY IN ADAPTING TO ENVIRONMENTAL VARIATIONS. PANDORINA CONSTITUTED A MAJOR MEMBER OF THE FLORA HIGHLY ADAPTABLE TO INTERACTION WITH DAIRY WASTES. PANDORINA COULD TOLERATE WIDE TEMPERATURE VARIATIONS (11 DEG TO 32 DEG C) AT A CONSTANT DEPTH OF 75 CM. OTHER ORGANISMS WERE RESPONSIVE TO SPECIFIC CONDITIONS AND WHEN THE DOMINANT GROUPS SUFFERED A SERIOUS SETBACK, THE SUBDOMINANTS FLOURISHED. BIOCHEMICAL OXYGEN DEMAND (BOD) REDUCTIONS WERE 80 TO 90 PERCENT AT A BOD LOADING RATE OF 220 LBS/ACRE/DAY (246 KG/DIA/DAY). (AGUIRRE-TEXAS)

EPA RELAXES ITS STANDARDS ON SEWAGE SETTLING PONDS.
ENGINEERING NEWS-RECORD, VOL. 199, NO. 16, P 15, OCTOBER, 1977.
05G;05D
SINCE COMPLIANCE WITH SECONDARY WASTE WATER TREATMENT STANDARDS SET BY THE 1972 FEDERAL WATER POLLUTION ACT MAY REQUIRE SMALL COMMUNITIES TO BUILD ELABORATE SEWAGE TREATMENT PLANTS AND ABANDON EXISTING SETTLING PONDS, THE EPA HAS MODIFIED ITS EFFLUENT QUALITY STANDARDS. UNDER THE NEW REGULATIONS, COMMUNITIES WHICH MEET THE BOD STANDARD OF 30 PPM OVER A 30-DAY AVERAGE WILL NOT BE REQUIRED TO COMPLY WITH THE EQUALLY STRICT STANDARD FOR SUSPENDED SOLIDS. THE RELAXED STANDARDS WILL BE ADJUSTED TO ACCOMODATE VARIATIONS IN CLIMATE AND GEOGRAPHY. LAGOON TREATMENT OF SEWAGE OR DECOMPOSITION IN AN ARTIFICIAL POND EXPOSED TO AIR AND SUNLIGHT IS CONSIDERED BY THE EPA AS A VIABLE ALTERNATIVE TO MORE EXPENSIVE MEANS OF SECONDARY TREATMENT. (SCHULZ-FIRL)

OXIDATION AND AERATED LAGOON OPERATION.
ETTER, E. R.
SAFFORD MUNICIPAL UTILITIES, ARIZ.
DEEDS AND DATA (WATER POLLUTION CONTROL FEDERATION), P D2-D3, MAY, 1974.
05D
THE PRIME RESPONSIBILITY OF A POND OPERATOR IS TO MONITOR AND AID NATURAL PROCESSES OF WASTE TREATMENT BY PROVIDING AN OPTIMUM ENVIRONMENT. HE SHOULD WATCH FOR SIGNS OF POND IMBALANCE (WATER COLOR, FLOATING SURFACE MATTER, ODOR EVOLUTION, AND CONDITIONS OF BANKS) AND OF SEPTICITY. HE SHOULD KEEP RECORDS OF DISSOLVED OXYGEN, PH, RELATIVE STABILITY, TEMPERATURE, AND WEATHER CONDITIONS; REMOVE WEEDS FROM THE WATER; AND HAVE SODIUM NITRATE AVAILABLE TO PREVENT ALGAL DIEOFF. (BROWN-IPC)

TREATMENT OF WASTES FROM A SOLE LEATHER TANNERY.
EYE, J. DAVID; LIU, LAWRENCE
CINCINNATI UNIV., OHIO.
JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 43, NO 11, NOVEMBER 1971, P 2291-2303, 10 FIG, 1 TAB, 12 REF.
*TANNERIES, *HIDES, SUSPENDED SOLIDS.
05D
PILOT PLANT AND FULL-SCALE TREATMENT STUDIES EXTENDING OVER A 3 YEAR PERIOD WERE CONDUCTED IN AN ATTEMPT TO DEVELOP A FEASIBLE WASTE TREATMENT PROCEDURE FOR TANNERY WASTES. WASTE CHARACTERIZATION STUDIES REVEALED THAT ABOUT 70% OF THE TOTAL POLLUTIONAL LOAD DISCHARGED INITIALLY WAS CONTAINED IN 3 OR 4 WASTE STREAMS COMPRISING ONLY 30% OF THE TOTAL VOLUME OF WASTES DISCHARGED. A WASTE REDUCTION PROGRAM WAS INSTITUTED, INCLUDING CONSERVATION, REUSE, AND PROCESS CHANGES. THE REMAINING LIQUID WASTES

WERE SEGREGATED AND PRETREATED AT POINT OF ORIGIN. IN A FULL SCALE SYSTEM, 10 MG/L OF ANIONIC POLYELECTROLYTE GAVE OPTIMUM REMOVAL (ABOUT 90%) OF SUSPENDED LIME PARTICLES, WHILE BOD REDUCTIONS OF THE OTHER WASTES IN BIOLOGICAL TREATMENT LAGOONS WERE 70 TO 90%. ODORS ARISING FROM TREATMENT OF BEAMHOUSE WASTES WERE CONTROLLED BY ADDITION OF TAN LIQUORS, BUT A DECREASE IN BOD REDUCTION EFFICIENCY ALSO RESULTED. FOAMING PROBLEMS WERE PARTLY CONTROLLED BY HIGH PRESSURE JETS AND DISINFECTION WAS ACHIEVED WITH 30 MG/L CHLORINE. CAPITAL COST WAS $40,000, AND OPERATING COSTS WERE REPORTED AS $15,000/YEAR FOR THE 800 M3D/DAY TANNERY'S TREATMENT SYSTEM. (LOWRY-TEXAS)

STRIPPING EFFLUENTS OF NUTRIENTS BY BIOLOGICAL MEANS.
FITZGERALD, GEORGE P.

WISCONSIN UNIV., MADISON. SANITARY LAB.
TRANS OF THE SEMINAR ON ALGAE AND METROPOLITAN WASTES, ROBERT A TAFT SAN ENGR CTR, CINCINNATI, 1961, PP 136-139, 5 FIG.
CSF
LABORATORY EXPERIMENTS WITH THE GREEN ALGA CHLORELLA PYRENOIDOSA (WIS 2005) HAVE SHOWN THIS ALGA WOULD FIRST ABSORB THE AMMONIUM-NITROGEN, THEN NITRITE-NITROGEN AND NITRATE-NITROGEN FROM SECONDARY SEWAGE EFFLUENTS. LESS THAN 0.5 MG/LITER OF ANY OF THE NITROGEN OR PHOSPHORUS OF THE EFFLUENT REMAINED IN SOLUTION AFTER 17 DAYS OF CULTURE. GROWTH OF CHLORELLA PARALLELED NITROGEN AND PHOSPHORUS REMOVAL IN PRIMARY AND SECONDARY EFFLUENT. GROWTH IN SECONDARY EFFLUENT COULD BE STIMULATED BY THE ADDITION OF CARBON DIOXIDE TO AIR. THE OPERATION OF A 1/2-ACRE STABILIZATION POND FOR NUTRIENT REMOVAL BY ALGAE IN THE POND INDICATED THAT A SUCCESSION OF ALGAL SPECIES TOOK PLACE DESPITE A CONTINUOUS SUPPLY OF NUTRIENTS. THE AVERAGE NITROGEN REMOVAL THROUGHOUT THE YEAR IS ABOUT 30%, WITH SUMMER REMOVALS REACHING ABOUT 70%. THERE WERE ONLY 33 DAYS DURING 1956 AND 76 DAYS DURING 1957 WHEN NITROGEN REMOVAL EXCEEDED 50%. PHOSPHORUS REMOVAL COINCIDED WITH PERIODS OF HIGH PH. DURING EARLY WINTER, POND EFFLUENT CONTAINED HIGHER LEVELS OF PHOSPHORUS THAN INFLUENT DUE TO DISSOLUTION OF PRECIPITATED PHOSPHORUS. (EICHHORN-WISC)

DESIGN GUIDES FOR BIOLOGICAL WASTE WATER TREATMENT PROCESSES PERFORMANCE OF THE AERATED LAGOON PROCESS.
FLECKSEDER, HELLMUT R.; MALINA, JOSEPH F., JR.
TEXAS UNIV., AUSTIN. CENTER FOR RESEARCH IN WATER RESOURCES.
TECHNICAL REPORT EHE-70-22, CRWR 71, DECEMBER 1970, 36 FIG, 14 TAB, 36 REF. FWQA GRANT NO WPRD 178-01-68.
*AERATED LAGOONS, DETENTION TIMES, SUSPENDED SOLIDS, AUSTIN(TEX).
05D
PLANT SCALE TANKS AT THE WILLIAMSON CREEK WASTE WATER TREATMENT PLANT WITH VOLUMES RANGING FROM 235,000 TO 6900,000 GALLONS PROVIDED DETENTION TIMES OF 10 HR TO 8 DAYS, AND LABORATORY SCALE TANKS AT THE GOVALLE WASTEWATER TREATMENT PLANT, OF 12 AND 9 LITERS IN VOLUME RESPECTIVELY, PROVIDED DETENTION TIMES OF 12, 8, AND 6 HOURS. INPUT WASTE WATER TO BOTH SYSTEMS CONTAINED 150 MG/L OF TOTAL BIOCHEMICAL OXYGEN DEMAND, AND 140 MG/L OF SUSPENDED SOLIDS. METHODS USED FOR DETECTION OF FOOD UTILIZATION BY THE MICROBES WERE OXYGEN UPTAKE AND SUBSTRATE CONCENTRATION. THREE SYSTEMS, INCLUDING ONE TANK, 2 TANKS IN SERIES AND 3 TANKS IN SERIES WERE OPERATED IN PARALLEL TO DETERMINE THE EFFECT OF STAGING UPON THE COMPLETENESS OF THE BIODEGRADATION. IT WAS DETERMINED THAT THE EFFLUENT QUALITY, BOTH SETTLED AND FILTERED, FROM THE THREE TANK SYSTEM, THE TWO TANK SYSTEM, AND THE SINGLE TANK SYSTEM WAS THE SAME FOR EQUAL DETENTION TIMES. THEREFORE, STAGING HAD NO DETECTABLE EFFECT UPON THE PROCESS AND WAS DISREGARDED. SUBSTRATE REMOVAL RATES (K) WERE OBTAINED FOR THE FILTERABLE FRACTION OF THE WASTEWATER. DATA REPRESENTING DAILY AVERAGE CAN BE CORRELATED BY THE STEADY-STATE MODEL, WHEREAS DATA OBTAINED OVER ONE DAY SHOULD BE CORRELATED TO A NON-STEADY-STATE MODEL. FOR THE STEADY-STATE MODEL AND SOLUBLE BOD, K=0.1 (DAY/+, AND FOR THE NON=STEADY=STATE MODEL AND SOLUBLE TOC, K=6.2 DAY/1; BOTH VALUES HOLD AT THE FIRST STAGE OF THE TANKS. (LOWRY-TEXAS)

THE DAN REGION LARGE SCALE OXIDATION PONDS.
FOLKMAN, Y.; KREMER, M.; MEIRING, P. G. J.
WATER PLANNING FOR ISRAEL LTD., TEL-AVIV. DAN REGION SEWAGE RECLAMATION PROJECT.
PREPRINT, PRESENTED AT SIXTH INTERNATIONAL WATER POLLUTION RESEARCH CONFERENCE, SESSION 7, HALL C, PAPER NO 16, JUNE 21, 1972. 12 P, 4 FIG, 2 TAB, 14 REF.
*RECIRCULATION RATIO, *ISRAEL(DAN REGION).
05D
ALTHOUGH MOST DESIGNERS RELEGATE OXIDATION LAGOONS TO ONLY THE SMALLEST INSTALLATIONS, LARGE SCALE OXIDATION LAGOONS DESIGNED TO HANDLE 22,000 CU. M. PER DAY OF RAW SEWAGE HAVE BEEN GIVING SATISFACTORY PERFORMANCE WITH EXCELLENT REDUCTIONS OF ALL INDICATORS OF POLLUTION. THE PONDS ARE PRESENTLY OPERATING

AT THEIR OVERALL DESIGN LOAD OF 230 KG BOD/DAY/HECTARE OF SURFACE AREA, BUT LOADING IS TO BE INCREASED QUITE GRADUALLY. THE PERFORMANCE OF THE PRIMARY PONDS DEPENDS ALMOST ENTIRELY ON THE 1.5 TO 1 RECIRCULATION RATE OF EFFLUENT FROM THE LAST POND IN THE RECIRCULATION POND SYSTEM BACK TO THE PRIMARY POND. NO ODOR PROBLEMS OR SLUDGE BUILD-UP PROBLEMS HAVE BEEN ENCOUNTERED. COST OF SEWAGE TREATMENT IN THE SECONDARY PONDS WAS INCREASED TO 2.6 U. S. CENTS PER CUBIC METER TREATED BECAUSE OF THE QUANTITIES OF SAND DUNES TO BE MOVED, AS WELL AS THE NECESSITY OF LINING THE BOTTOMS. HOWEVER, A 65 TO 70% REDUCTION OF AN AVERAGE 90 MG/L TOTAL NITROGEN INFLUENT IS ACCOMPLISHED AT THIS PRICE, FAR LESS THAN THE COST OF REMOVING NITROGEN BY ANY OTHER BIOLOGICAL MEANS. (LOWRY-TEXAS)

SEPARATION OF ALGAE CELLS FROM WASTEWATER LAGOON EFFLUENTS BY SOIL MANTLE TREATMENT.
GEARHEART, R. A.; MIDDLEBROOKS, E. J.
UTAH STATE UNIV., LOGAN. DIV. OF ENVIRONMENTAL ENGINEERING.
IN: UPGRADING WASTEWATER STABILIZATION PONDS TO MEET NEW DISCHARGE STANDARDS, AUGUST 21-23, 1974, LOGAN, UTAH. UTAH STATE UNIVERSITY, P 137-186. 6 FIG. 24 TAB, 204 REF. 1 APP.
*SOIL MANTLE TREATMENT, LAND PLANNING, UTAH WATER QUALITY STANDARDS.
05D;05E
A REVIEW OF THE HISTORY OF SEWAGE DISPOSAL BY WASTE WATER IRRIGATION OR SOIL MANTLE DISPOSAL OF LAGOON EFFLUENT IS PRESENTED. AN EXPERIMENTAL DESIGN OF A SOIL MANTLE DISPOSAL SYSTEM IS DESCRIBED. THE LIMITATIONS OF POND EFFLUENT USED AS IRRIGATION WATER FOR CROPS WERE INVESTIGATED. LAND PLANNING TECHNIQUES TO MAKE PONDS MORE VISUALLY PLEASING ARE STUDIED. THE DIFFERENCE BETWEEN CLASS C AND CLASS D UTAH WATER QUALITY STANDARDS ARE GIVEN. THE MOST SIGNIFICANT DIFFERENCE IS IN THE 5 DAY BIOCHEMICAL OXYGEN DEMAND (BOD(5)). CLASS D IS 25 MG/LITER AND CLASS C IS 5 MG/LITER. CLASS C STANDARDS IN GENERAL CANNOT BE MET BY WASTE STABILIZATION PONDS. ECONOMICALLY, THEY ARE VERY FEASIBLE, SO ANOTHER MEANS OF DISPOSING OF THE EFFLUENT IS SUGGESTED. IRRIGATION. WASTE STABILIZATION POND DEPTH, DETENTION TIME, SHAPE, MIXING AND LOADING ARE DISCUSSED. TOO OFTEN, LAND PLANNING HAS BEEN NEGLECTED. IT SHOULD BE BASED ON THE NATURE OF THE SITE, AND THE HUMAN PURPOSES FOR WHICH IT WILL BE USED. PLANNING TECHNIQUES SHOULD ACCOUNT FOR ODOR, MIXING BY WIND ACTION, INSECTS, TYPE OF SITE, WATER TABLE DEPTH, AND TOPOGRAPHY. THE USE OF NATURAL BERMS AND TREES TO REDUCE ODORS AND ATTRACT INSECT EATING BIRDS SHOULD BE CONSIDERED. THE BENEFICIAL OR TOXIC EFFECTS OF SALINITY, ALKALINITY, AND OTHER ELEMENTS ARE DISCUSSED. WATER QUALITY FACTORS IN RELATION TO SPECIFIC CROPS ARE SUMMARIZED. LAND REQUIREMENTS FOR EFFLUENT DISCHARGE ARE ALSO CONSIDERED. SOME CASE HISTORIES ON THE USE OF EFFLUENTS FOR IRRIGATION ARE BRIEFLY PRESENTED.

RECENT PAPER INDUSTRY WASTE TREATMENT SYSTEMS.
GILLESPIE, WILLIAM J.
NATIONAL COUNCIL FOR AIR AND STREAM IMPROVEMENT INC., GAINESVILLE, FLA. SOUTHERN RESEARCH CENTER.
JOURNAL OF SANITARY ENGINEERING DIVISION, PROCEEDINGS OF ASCE, VOL 96, NO. SA 2, APRIL 1970, P 467-477, 3 FIG, 6 REF.
SUSPENDED SOLIDS.
05D
AS OF 1966, THE PULP AND PAPER INDUSTRY HAD EXPENDED A TOTAL OF $217 MILLION OF CAPITAL INVESTMENT IN WASTE TREATMENT FACILITIES. TO PROVIDE TREATMENT COMPATIBLE TO THE WATER QUALITY ACT CRITERIA, THE CAPITAL COST IS ESTIMATED TO BE BETWEEN $320 MILLION TO $920 MILLION. PRIMARY TREATMENT REMOVAL METHODS ARE OUTLINED WITH RESPECT TO THEIR APPLICATION TO THE PULP AND PAPER INDUSTRY. BOTH EARTHEN AND CONCRETE SEDIMENTATION BASINS ARE USED. SUSPENDED SOLIDS AND BOD REMOVALS ARE DEPENDENT ON THE INFLUENT, AND RANGE FROM 70 TO 100% AND 15% TO 80% RESPECTIVELY. STABILIZATION BASINS ARE THE MOST WIDELY USED SECONDARY TREATMENT FACILITIES. AT LOADING RATES OF UP TO 50 LBS BOD PER ACRE, 85% REMOVALS ARE BEING ACHIEVED. EFFLUENTS ARE GENERALLY NUTRIENT DEFICIENT, SO NUTRIENTS ARE ADDED IN THE RATIO OF 100 TO 5 TO 1, BOD TO N TO P. TRICKLING FILTERS HAVE ALSO BEEN USED AS ROUGHING DEVICES, BECAUSE OF THEIR ABILITY TO BE LOADED AT RATES OF UP TO 200 LBS BOD PER 1000 FT. OF FILTER VOLUME. CASE HISTORIES OF BOTH AN AERATED BASIN SYSTEM AND AN ACTIVATED SLUDGE SYSTEM ARE PRESENTED AS ILLUSTRATIONS.

BASIS FOR WASTE STABILIZATION POND DESIGNS.
GLOYNA, EARNEST F.
TEXAS UNIV., AUSTIN.
ADVANCES IN WATER QUALITY IMPROVEMENT, (EDITORS: GLOYNA, E. F., AND ECKENFELDER, W. W., JR.), AUSTIN, TEXAS, UNIV OF TEXAS PRESS, 1968. P 397-408. 1 FIG. 1 TAB, 19 REF.
*WASTE STABILIZATION PONDS, *ALGAL PHYSIOLOGY, *DESIGN THEORY AND CALCULATIONS, PHOTOSYNTHESIS, ILLUMINATION, TEMPERATURE, NUTRIENTS, FACULTATIVE POND DESIGNS, BOD, SLUDGE.

MANY PROBLEMS ARISING FROM USE OF WASTE STABILIZATION PONDS ARE TRACEABLE TO INADEQUATE ENGINEERING, POOR MAINTENANCE AND LACK OF OPERATIONAL SUPERVISION. HOWEVER, THERE IS A MORE FUNDAMENTAL NEED: DESIGN AND ENGINEERING FOR SYSTEMS USING STABILIZATION PONDS MUST BE BASED ON AN UNDERSTANDING OF THE PRINCIPLES OF ALGAL PHYSIOLOGY. GENERALLY, ALGAE GROWING IN A STREAM OR A WASTE STABILIZATION POND ARE IN A HIGHLY COMPETITIVE ENVIRONMENT. ONE OR MORE OF THE FACTORS NECESSARY FOR PHOTOSYNTHESIS ARE INTERRELATED, AND UNICELLULAR ALGAE, IN PARTICULAR WILL REACT RAPIDLY TO ENVIRONMENTAL CHANGES. ILLUMINATION, TEMPERATURE, AND NUTRIENTS--THE FACTORS WHICH AFFECT GROWTH RATE ARE EXAMINED CRITICALLY. THE PHENOMENA OF ALGAL PHYSIOLOGY, TOGETHER WITH ACTUAL TREATMENT OBJECTIVES ARE SYNTHESIZED IN GOOD DESIGN. IN THE FINAL ANALYSIS, THE SPECIFIC DESIGN OF A WASTE STABILIZATION POND DEPENDS HEAVILY UPON THE SPECIFICALLY-IMPOSED TREATMENT OBJECTIVES AND REQUIREMENTS. A POND SYSTEM MAY BE DESIGNED TO RECEIVE UNTREATED SEWAGE OR INDUSTRIAL WASTES, PRIMARY OR SECONDARY TREATMENT EFFLUENTS OR EXCESS ACTIVATED SLUDGES AND SETTLEABLE SOLIDS. CERTAIN CRITICAL FACTORS IN DESIGN DEVELOPMENT ARE DISCUSSED, BASED ON OPERATIONAL EXPERIENCES AND RESEARCH WHICH PROVIDE VITAL INSIGHTS INTO ENVIRONMENTAL FACTORS GOVERNING WASTE STABILIZATION PROCESSES. (D'AREZZO-TEXAS)

ESTABLISHING THE BASIS FOR A WASTEWATER TREATMENT PLANT DESIGN
GLOYNA, E. F.
TEXAS UNIV. AT AUSTIN, DEPT. OF CIVIL ENGINEERING.
BOLETIN DE LA ACADEMIA DE CIENCIAS FISICAS, MATHEMATICAS Y NATURALES, CARACAS, VOL 37, NO 111, P 31-46, FIRST TRIMESTER, 1977. 10 FIG, 3 TAB, 10 REF.
FIELD 05D
AN ANALYSIS OF THE MICROBIAL PROCESSES IN WASTE STABILIZATION IS PRESENTED AS PART OF A DISCUSSION ON THE BASIC DESIGN CONCEPTS OF AEROBIC, ANAEROBIC, AND FACULTATIVE BIOLOGICAL WASTE WATER TREATMENT SYSTEMS. KINETIC EQUATIONS ARE PRESENTED FOR THE NET RATE OF GROWTH OF MICROORGANISMS AND SUBSTRATE UTILIZATION IN BIOLOGICAL TREATMENT SYSTEMS. PROCESS EFFICIENCY IS RELATED TO THE SPECIFIC REMOVAL OF SOME SOLUBLE SUBSTRATE OR THE COMBINED REMOVAL OF BOD IN ALL FORMS. AERATED LAGOONS WITH BIOMASS RECYCLING AND THE CONTINUOUS ACTIVATED SLUDGE PROCESS WITHOUT BIOMASS RECYCLING COMPRISE THE MAJOR TYPES OF AEROBIC SYSTEMS. EQUATIONS FOR MATERIALS BALANCE, OXYGEN REQUIREMENTS, AND SLUDGE PRODUCTION IN AEROBIC TREATMENT SYSTEMS ARE PRESENTED. ANAEROBIC DEGRADATION INVOLVES HYDROLYSIS AND SUBSEQUENT FERMENTATION OF ORGANIC WASTES WITH THE CONVERSION OF VOLATILE ACIDS INTO METHANE AND CARBON DIOXIDE BY ANAEROBIC SYSTEM ARE DISCUSSED WITH RESPECT TO TEMPERATURE, PH, OXIDATION-REDUCTION POTENTIAL, VOLATILE ACIDS CONCENTRATION, AND ALKALINITY. FACULTATIVE WASTE STABILIZATION PONDS RELY ON THE OXIDATION OF CARBONACEOUS ORGANICS BY AEROBIC AND FACULTATIVE BACTERIA, NITRIFICATION, REDUCTION OF CARBONACEOUS ORGANICS BY ANAEROBIC BACRERIA, AND OXYGENATION OF SURFACE LIQUIDS BY ALGAE. GUIDELINES ARE PRESENTED FOR POND DEPTH, SURFACE AREA, AND TEMPERATURE. (SCHULZ-FIR_)

NEW EXPERIMENTAL POND DATA.
GLOYNA, E. F.; AGUIRRE, J.
TEXAS UNIV., AUSTIN. ENVIRONMENTAL HEALTH ENGINEERING RESEARCH LAB.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS. JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 200-210. 3 FIG, 10 TAB, 10 REF.
LABORATORY SCALE, *TOTAL ORGANIC CARBON.
05D
THREE LABORATORY-SCALE UNITS AND THREE PILOT-SCALE UNITES WERE CONSTRUCTED AND OPERATED FOR A PERIOD OF EIGHT MONTHS AT THE CONVENTIONALLY ACCEPTED LOADING RATES OF 70 LBS BODU/ACRE/DAY AND 65 DAY DETENTION TIME FOR THE PILOT SCALE PLANTS, WITH ONLY 10 LBS BODU/ACRE/DAY AND 90 DAYS DETENTION TIME IN THE LAB SCALE UNITS. THE ONLY DIFFERENCE IN THE THREE UNITS WAS THE LOCATION OF THE ANAEROBIC SLUDGE DEPOSITION ZONE. ORGANIC REMOVAL EFFICIENCIES WERE DETERMINED BY TESTS ON BOD5, COD, AND TOC. SUSPENDED SOLIDS REMOVAL WAS DETERMINED BY MEMBRANE FILTER ANALYSIS, AND GENERAL POND CHARACTERISTICS WERE EVALUATED THROUGH MEASUREMENT OF PH, DO, TEMPERATURE, NITROGEN, PHOSPHORUS, AND ALGAE TYPING. FROM THIS EXPERIMENTAL EVALUATION, IT WAS DETERMINED THAT PILOT SCALE SYSTEMS ARE OF CONSIDERABLE VALUE IN ARRIVING AT DESIGN CRITERIA FOR A PARTICULAR WASTE IN A PARTICULAR LOCALITY. PILOT PLANTS LACK MANY OF THE DISADVANTAGE OF LAB SCALE PLANTS MAINLY DUE TO THE INCREASED SIZE, AND THEREFORE, DECREASED SENSITIVITY OF THE PILOT PLANTS. ALSO, SERIES ARRANGEMENT OF A MULTIPLE POND SYSTEM HAD A MUCH GREATER EFFECT THAN DID CHANGING THE LOCATION OF THE SLUDGE DEPOSITION ZONE. ONE OF THE POND SYSTEMS UTILIZED FOR THIS STUDY OPERATED ON THE SAME PRINCIPAL AS A SERIES POND ARRANGEMENT, AND THE ANAEROBIC PRETREATMENT PORTION OF THE SYSTEM PROVIDED 50 TO 76% REDUCTION OF ORGANIC MATERIAL IN FROM 3 TO 5 DAYS BETWEEN 12 AND 24C.

COMBINED NUTRIENT REMOVAL AND TRANSPORT SYSTEM FOR TILE DRAINAGE FROM THE SAN JOAQUIN VALLEY.
GOLDMAN, JOEL C.; ARTHUR, JAMES F.; OSWALD, WILLIAM J.; BECK, LOUIS A.
CALIFORNIA STATE DEPT. OF WATER RESOURCES, FRESNO; AND FEDERAL WATER QUALITY ADMINISTRATION, FRESNO.
IN: COLLECTED PAPERS REGARDING NITRATES IN AGRICULTURAL WASTE WATERS, FEDERAL WATER QUALITY ADMINISTRATION WATER POLLUTION CONTROL RESEARCH SERIES 13030 ELY, 12/69, P 165-186, DECEMBER 1969, 22 P, 4 FIG, 1 TAB, APPEND, FWQA PROJECT 13030 ELY.
*ALGAE HARVESTING, *CENTRAL VALLEY(CALIF.).
05D;05G;05B
CURRENT PLANS CALL FOR TREATMENT OF AGRICULTURAL WASTE WATER FOR NUTRIENT (NITROGEN) REMOVAL FROM THE PROPOSED SAN LUIS AND MASTER DRAINS PRIOR TO DISCHARGE INTO THE BAY-DELTA AREA. OF THE SEVERAL TREATMENT PROCESSES BEING INVESTIGATED, THE ALGAE STRIPPING PROCESS IS ESTIMATED TO REQUIRE BETWEEN 6,000 AND 12,000 ACRES OF LAND TO ACCOMPLISH THIS TASK. BECAUSE EVERY BODY OF WATER IS A POTENTIAL ALGAL GROWTH SYSTEM, THERE ARE SEVERAL ALTERNATIVES WHICH WILL GREATLY REDUCE THE TOTAL COST OF TREATMENT AND PERHAPS IMPROVE THE OVERALL EFFICIENCY OF NUTRIENT REMOVAL. IN-LINE TREATMENT USING THE DRAIN AND THE DRAINAGE RESERVOIRS FOR ALGAE GROWTH MAY BE AN ECONOMICAL AND PRACTICAL METHOD FOR NUTRIENT REMOVAL. BECAUSE KESTERSON RESERVOIR IS AN INTEGRAL PART OF THE PROPOSED DRAINAGE SYSTEM AND CONTAINS THE REQUIRED AREA NEEDED FOR TREATMENT BY ALGAE STRIPPING, IT SEEMS LOGICAL TO USE IT AS A DUAL-PURPOSE TREATMENT AND STORAGE RESERVOIR. KESTERSON RESERVOIR, IF MODIFIED AS SUGGESTED, HAS THE POTENTIAL TO PROVIDE NITROGEN REMOVALS IN EXCESS OF 90%.

3-STAGE PONDS EARN PLAUDITS.
GOSWAMI, R.; BUSCH, W. H.
WATER AND WASTES ENGINEERING, VOL 9, NO 4, P 40-43, APRIL 1972, 3 FIG, 6 REF.
*STABILIZATION PONDS.
05D
TO EVALUATE THE EFFECTIVENESS OF SERIES-OPERATED LAGOONS IN TREATING DOMESTIC WASTE, 3-STAGE WASTE STABILIZATION PONDS WERE STUDIED IN DETAIL TO INCLUDE EFFECTS DUE TO SEASONAL VARIATIONS. METHODOLOGY INCLUDED MEASURING PARAMETERS SUCH AS PH, TEMPERATURE, TOTAL ALKALINITY, BOD, PHOSPHATE, NITRATE, SYNTHETIC DETERGENTS, ALGAE COUNTS, AND OBSERVATION OF PHYSICAL DETERMINANTS SUCH AS COLOR, ODOR, ICE FORMATION, AND PRESENCE OF FLORA AND FAUNA. RESULTS INDICATE THAT, ON THE AVERAGE, THE FIRST POND REMOVED 86% OF INFLUENT BOD; THE FIRST TWO PONDS TOGETHER REMOVED 79% OF THE PHOSPHATE IN THE RAW WASTE; MOST OF THE SYNTHETIC DETERGENT WAS REMOVED IN THE FIRST POND. NO CORRELATION SEEMINGLY EXISTED BETWEEN DATA OF PHOSPHATE AND SYNTHETIC DETERGENT IN THE RAW WASTE; PHOSPHATE RATHER THAN NITRATE WAS THE LIMITING FACTOR FOR GROWTH OF ALGAE. PHOTOSYNTHETIC ACTIVITY WAS DETERRED BECAUSE OF ICE COVER AND ALGAL CONCENTRATIONS INCREASED WITH MELTING OF THE ICE. THERE WAS NO AESTHETIC PROBLEM IN THE FORM OF ODOR IN THE VICINITY OF THE TREATMENT SITE. (ANDERSON-TEXAS)

OPTIMIZE THE EFFLUENT SYSTEM - PART 4: APPROACH TO CHEMICAL TREATMENT.
GRUTSCH, J. F.; MALLATT, R. C.
STANDARD OIL CO., CHICAGO, ILL.
HYDROCARBON PROCESSING, VOL. 55, NO. 6, P 115-123, JUNE, 1976. 18 FIG, 4 TAB.
*CHEMICAL TREATMENT.
5D
METHODS FOR OPTIMIZING THE TREATMENT OF PETROLEUM REFINERY EFFLUENTS ARE DISCUSSED. EXAMPLES AND CASE HISTORIES ARE PRESENTED FOR THE FOLLOWING FOUR COLLIDAL SYSTEMS: DISPERSED SILICA, SUSPENDED MATTER IN API SEPARATOR EFFLUENT, BIOCOLLOIDS IN FRESH WATER AERATED LAGOON EFFLUENT AND BIOCOLLOIDS IN BRACKISH WATER AERATED LAGOON EFFLUENT. SPECIFIC TOPICS COVERED INCLUDE: THE RESPONSE OF COLLOIDALLY DISPERSED SILICA TO DESTABILIZATION CHEMICALS AND AN INDIFFERENT ELECTROLYTE; THE COMPARATIVE EFFECTIVENESS OF CATIONIC POLYELECTROLYTES FOR THE CHARGE NEUTRALIZATION OF SUSPENDED MATTER IN API SEPARATOR EFFLUENTS AS DETERMINED BY ZETA POTENTIAL TITRATION CURVES; POLYELECTROLYTE SYNERGISMS AND ANTAGONISMS IN SALINITY, PH, AND SULFIDES IN API SEPARATOR EFFLUENTS; THE COMPARATIVE EFFECTIVENESS OF CATIONIC POLYELECTROLYTES FOR THE CHARGE NEUTRALIZATION OF BIOCOLLOIDS IN AERATED LAGOON EFFLUENT; AND THE DETERMINATION OF OPTIMAL CHEMICAL TREATMENT FOR BIOCOLLOIDS IN BRACKISH WATERS USING ZETA POTENTIAL MEASUREMENTS AT LOW SPECIFIC CONDUCTANCE TO INSURE THAT CHARGE NEUTRALIZATION IS THE PREDOMINANT DESTABILIZATION MECHANISM. (KREAGER-FIRL)

INTERMITTENT SAND FILTRATION FOR UPGRADING WASTE STABILIZATION POND EFFLUENTS.
HARRIS, S. E.; REYNOLDS, J. H.; HILL, D. W.; FILIP, D. S.; MIDDLEBROOKS, E. J.
UTAH WATER RESEARCH LAB., LOGAN.

JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 49, NO 1, P 83-102, JANUARY, 1977. 12 FIG, 9 TAB, 7 REF, 1 APPEND.
*SAND FILTRATION.
05D
A SIMPLE, ECONOMICAL, LOW MAINTENANCE TREATMENT METHOD WAS FOUND NECESSARY FOR POLISHING LAGOON EFFLUENT TO MEET THE REQUIREMENTS OF PL 92-500. THE NEED WAS ESPECIALLY URGENT BECAUSE MANY COMMUNITIES WITH A POPULATION OF LESS THAN 5,000 USE STABILIZATION PONDS FOR ECONOMICAL WASTE WATER TREATMENT AND LACK OPERATORS AND MAINTENANCE CREWS HAVING A HIGH DEGREE OF TECHNICAL KNOWLEDGE. RESEARCH INDICATED THAT INTERMITTENT SAND FILTERS MIGHT ECONOMICALLY SATISFY THE DEMANDS OF THIS LEGISLATION. THE LENGTH OF FILTER RUN WAS FOUND TO BE RELATED TO THE INFLUENT SUSPENDED SOLIDS CONCENTRATION AND THE HYDRAULIC LOADING RATE, AS WELL AS TO ALGAL GROWTH IN THE STANDING WATER ABOVE THE FILTER. THESE FILTERS CAN PRODUCE AN EFFLUENT WITH A BOD OF LESS THAN 100 MILLIGRAMS/LITER AND A SUSPENDED SOLIDS CONCENTRATION OF LESS THAN 10 MILLIGRAMS/LITER, AS WELL AS A VOLATILE SUSPENDED SOLIDS CONCENTRATION OF LESS THAN 5 MILLIGRAMS/LITER. WINTER EFFLUENT QUALITY WAS SLIGHTLY LOWER THAN WARM WEATHER EFFLUENT QUALITY, BUT WINTER OPERATION CREATED NO SERIOUS PROBLEMS. OPTIMUM SINGLE STAGE INTERMITTENT SAND FILTER HYDRAULIC LOADINGS WERE ABOUT 0.4 TO 0.6 MILLION GALLONS/ACRE/DAY. (COLLINS-FIRL)

CHLORINATION SEEMS BEST FOR REMOVING SUSPENDED SOLIDS FROM LAGOON EFFLUENTS.
HARRISON, R. B.; HADDOCK, J. K.
GILBREATH, FOSTER AND BROOKS, INC., TUSCALOOSA, ALA.
WATER AND WASTES ENGINEERING, VOL 14, NO 5, P 48-82, MAY, 1977. 4 FIG, 4 TAB.
VERNON(AL).
05D
AMONG THE PROBLEMS ENCOUNTERED WITH THE USE OF LAGOONS OR HOLDING PONDS ARE THE PERIODICALLY HIGH LEVELS OF BOD, ALGAE, AND FECAL COLIFORM BACTERIA FOUND IN LAGOON EFFLUENTS. IN THIS STUDY ON THE IMPROVEMENT OF AN EXISTING 3-CELLED LAGOON IN VERNON, ALABAMA, FOUR EFFLUENT TREATMENT SCHEMES WERE EVALUATED. THE FIRST METHOD INVESTIGATED WAS CHLORINATION USING A CHLORINE CONTACT CHAMBER (REACTOR). IT APPEARED TO BE THE BEST METHOD FOR REDUCTION OF BOD, DESTRUCTION AND SETTLING OF ALGAE, AND ELIMINATION OF FECAL COLIFORM BACTERIA. THE EFFLUENT AND CHLORINE WERE FED INTO A MODEL REACTOR CHAMBER BY MEANS OF GRAVITY FLOW AND DETAINED FOR 2 HOURS. THE MODEL SYSTEM WAS EFFECTIVE AT REMOVING 68% OF THE BOD, 63% OF THE SOLIDS, AND 100% OF THE FECAL COLIFORM FROM THE LAGOON EFFLUENT. COAGULATION-PRECIPITATION WITH ALUM, THE SECOND METHOD INVESTIGATED, REMOVED AS MUCH AS 83% OF THE SOLIDS BUT DID NOT APPRECIABLY REDUCE BOD OR COLIFORM LEVELS. A MAJOR DISADVANTAGE OF THIS METHOD WAS THE PRODUCTION OF LARGE VOLUMES OF SLUDGE WHICH WOULD REQUIRE ADDITIONAL PROCESSING. PLAIN SEDIMENTATION, THE THIRD METHOD EXAMINED, DID NOT PROVE SATISFACTORY, RESULTING IN A SMALL PERCENTAGE OF REMOVAL OF SUSPENDED SOLIDS AND NON REDUCTION OF BOD OR FECAL COLIFORM LEVELS IN THE EFFLUENT. THE FOURTH METHOD, SAND FILTRATION, WAS CONSIDERED TO BE ADEQUATE FROM OTHER SOURCE STUDIES. (SCHULZ-FIRL)

LIGHT INTENSITY AND THE VERTICAL DISTRIBUTION OF ALGAE IN TERTIARY OXIDATION PONDS.
HARTLEY, WILLIAM R.; WEISS, CHARLES M.
NORTH CAROLINA UNIV., CHAPEL HILL. DEPT. OF ENVIRONMENTAL SCIENCES AND ENGINEERING.
WATER RESEARCH, VOL 4, NO 11, NOV 1970, P 751-763. 7 FIG, 2 TAB, 18 REF.
DURHAM(NC).
05D
FIVE OXIDATION PONDS AT THE THIRD FORK TREATMENT PLANT IN DURHAM, NORTH CAROLINA, WERE INVESTIGATED TO DETERMINE THE OPTIMUM LIGHTING CONDITIONS, THE TYPES OF ORGANISMS PRESENT IN DIFFERENT SITUATIONS, AND THEIR VERTICAL DISTRIBUTION IN THE POND LEVELS. SAMPLES IN THE PONDS WERE TAKEN AT 3,6,9,12,15,18,21,24 INCHES, AND THE SLUDGE LAYER. THESE SAMPLES WERE TAKEN EVERY TWO HOURS OVER THE 24 HOUR DIURNAL CYCLE. THE SAMPLES WERE PRESERVED IN 3% FORMALIN, AND THEN TAKEN TO THE LABORATORY FOR ANALYSIS. LIGHT INTENSITY, PH, DISSOLVED OXYGEN, AND TEMPERATURE WERE ALSO RECORDED AT THE TIME OF SAMPLING. THE SAMPLES TAKEN WERE COUNTED FOR NUMBER OF ORGANISMS PRESENT, AND, ALSO CENTRIFUGED FOR IDENTIFICATION OF SPECIES PRESENT IN LESSER NUMBERS. THE SURFACE WEIRS INSTALLED IN THE PONDS AFFECT THE CHEMICAL AND PHYSICAL PARAMETERS OF POND PERFORMANCE WITH PARTICULAR REFERENCE TO THE DISSOLVED OXYGEN CONCENTRATION, IT BEING MUCH LOWER IN THE POND WHICH ALLOWED THE MAT TO FORM AT THE SURFACE. EUGENA ROSTIFERA WILL CHANGE THEIR VERTICAL POSITION IN THE POND TO REACH THE POINT OF SUBMERGENCE WHERE THE LIGHT INTENSITY IS 75 CANDLES/FT2, WHERE THEY WERE NOT ABLE TO MOVE TO RETREAT FROM HIGH LIGHT INTENSITY CYSTS WERE FORMED. (LOWRY-TEXAS)

A THERMODYNAMIC ANALYSIS OF A PRIMARY WASTE STABILIZATION POND,
HENDRICKS, D. W.; POTE, W. D.; ANDREW, J. G.
UTAH STATE UNIV., LOGAN. UTAH WATER RESEARCH LAB.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE AS PB-205 282, $3.00 IN PAPER COPY, $0.95 IN MICROFICHE. REPORT NO PRCWRR 16-1, SEPTEMBER 1970, 63 P, 14 FIG, 7 TAB, 40 REF. OWRR A-006-UTAH(1).
*SOLAR INSOLATION, *STOICHIOMETRY.
05D
A 97.5 ACRE OXIDATION POND WITH AN AVERAGE DEPTH OF 1 1/2 TO 1 2/3 METERS, IN OPERATION SINCE 1967, WAS SAMPLED IN SEPTEMBER 1969 AND IN JUNE 1970. THE PRIMARY OBJECTIVE WAS TO QUANTITATE THE ACTUAL ENERGY TRADE-OFF, IN TERMS OF ALGAE PRODUCED VS. AMOUNT OF WASTE DEGRADED, FOR OXIDATION PONDS. SUCH QUANTITATION WAS ACCOMPLISHED BY: (1) DEFINING THE CHEMICAL REACTIONS INVOLVED-BOTH STOICHIOMETRICALLY AND THERMODYNAMICALLY (THE LATTER IN TERMS OF EQUILIBRIUM CONDITIONS); (2) MEASURING TERMS IN A DAILY MASS BALANCE MODEL OF AN OPERATING PRIMARY POND; AND (3) EVALUATING THE 'ALGAE PRODUCTION POTENTIAL' FOR THE POND STUDIED, BASED UPON AVAILABLE SOLAR INSOLATION. THESE RESULTS DEFINED RESPECTIVELY: (1) THE CALCULATED ABSOLUTE LOWER LIMIT OF DAILY ALGAL SYNTHESIS NECESSARY FOR PRODUCTION OF THE STOICHIOMETRIC OXYGEN TO SATISFY THE DAILY INFLUENT BOD REQUIREMENT; (2) A MEASURED DAILY SYNTHESIS RATE OF ALGAE TO COMPARE WITH THE DAILY INFLUENT TOC, UNDER CONDITIONS OF MAXIMUM SUNSHINE IN THE ANNUAL CYCLE; AND (3) THE CALCULATED ABSOLUTE UPPER LIMIT OF DAILY ALGAL SYNTHESIS, THROUGH THE ANNUAL CYCLE, IF ALL USABLE SOLAR ENERGY WERE UTILIZED. RESULTS ESTABLISHED: (1) ALGAE PRODUCTION IS SIGNIFICANT IN PROPORTION TO WASTE DEGRADED, EVEN IN THE LOWER LIMIT; (2) ACTUAL PRODUCTION WAS OVER 100 TIMES THE STOICHIOMETRIC AMOUNT; AND (3) THE UPPER PRODUCTION LIMIT WAS OVER 3 TIMES THE ACTUAL PRODUCTION. ALL RESULTS INDICATED A VAST ENERGY OVERTURN WITH LITTLE OR NO NET EFFECT. (LOWRY-TEXAS)

CHLORINATION OF WASTE POND EFFLUENTS,
HON, LEONARD W.
SACRAMENTO STATE COLL., CALIF.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 151-155, 7 FIG, 4 TAB, 15 REF. NATIONAL SCIENCE FOUNDATION GRANT GY3799, NATIONAL INSTITUTE OF HEALTH, USPHS, WP00026-RS.
*RESIDUAL, MOST PROBABLE NUMBER.
05D;05F
A TWO YEAR SERIES OF TESTS WERE PERFORMED ON EFFLUENT FROM EXPERIMENTAL STABILIZATION LAGOONS OF THE CITY OF CONCORD, CALIFORNIA, IN AN ATTEMPT TO DETERMINE METHODS FOR CONTROLLING ALGAE KILL BY CONTROLLING CHLORINE DOSAGE. THREE DAY COMPOSITE SAMPLES, OF 500 ML VOLUME, WERE TAKEN AT THREE-HOUR INTERVALS, AND THE CHLORINE DEMAND WAS DETERMINED BY THE DT TEST USING A 30 MIN. CONTACT TIME. IN ADDITION, THE SAMPLES WERE ANALYZED FOR BOD LEVELS AND FOR COLIFORM POPULATION. SELECTIVE CHLORINATION OF STABILIZATION LAGOON EFFLUENTS CAN BE ACCOMPLISHED. CONTROL OF REACTION AND CHLORINE CONCENTRATION IS CRITICAL, SINCE EXCESSIVE CHLORINE CAN RELEASE NUTRIENTS FROM ALGAL CELLS, THEREBY INCREASING THE BOD. THE SOLUTION LIES IN EXPERIMENTAL OPTIMIZATION OF BOTH CHLORINE DOSAGE AND RESIDUAL CHLORINE CONCENTRATIONS. TIME-CONCENTRATION RELATIONSHIPS REPORTED HERE PROVIDE A RATIONAL SET OF PROCESS DESIGN PARAMETERS FOR CHLORINE DISINFECTION IN ALGAL-BACTERIAL SYSTEMS.

EFFECTS OF TOXIC ORGANICS ON PHOTOSYNTHETIC REOXYGENATION,
HUANG, JU-CHANG; GLOYNA, EARNEST F.
TEXAS UNIV., AUSTIN. CENTER FOR RESEARCH IN WATER RESOURCES.
TECHNICAL REPORT NO. EHE-07-6701, CRWR-20, AUGUST 1967, 163 P, 64 FIG, 24 TAB, 78 REF. EPA GRANT WP-00668-03.
05C;05D
THE RELATIVE TOXICITY OF 33 PHENOLIC-TYPE COMPOUNDS AND 8 PESTICIDES WAS INVESTIGATED TO DETERMINE THE EXTENT TO WHICH CHLOROPHYLL INHIBITION BY CERTAIN INDUSTRIAL WASTES DECREASES STREAM DISSOLVED OXYGEN CONTENTS. PHENOLIC-TYPE GROUPS INCLUDED THOSE WITH MONO-AND POLY-SUBSTITUTED GROUPS SUCH AS -BR, -CL, -CH3, -NO2, -NH2, AND -OH. PESTICIDES STUDIED INCLUDED DDT, LINDANE, 2,4-D, SODIUM SALT OF 2, 4-D, 2, 45-T, DOW SODIUM TCA, DOW ESTERON 99, AND DOW FORMULA 40. ORGANIC COMPOUND TOXICITY WAS EVALUATED IN TWO WAYS. FIRST, TEST TUBE ALGAL CULTURES WERE GROWN AND CHEMOSTATED AT 25C UNDER CONTINUOUS ILLUMINATION FOR 72 HOURS. KNOP'S SOLUTION, INCLUDING THE HUTNER-EDTA MICRO ELEMENT SYSTEM, WAS USED AS CULTURE MEDIUM, AND A 5% CARBON DIOXIDE IN AIR GAS WAS BLOWN THROUGH TO SUPPLY THE INORGANIC CARBON SOURCE AND THE MIXING. SECONDLY, WARBURG MANOMETRIC TECHNIQUES WERE USED TO MEASURE GAS EXCHANGE OCCURING WHEN CARBONATE-BICARBONATE BUFFER IS USED AS A SUSPENDING FLUID. RESULTS SHOWED THE DECREASE IN CHLOROPHYLL CONTENT TO BE GENERALLY LOGARITHMIC TO TOXIC ORGANIC CONCENTRATION, WITH SUBSEQUENT SUPPRESSED OXYGEN PRODUCTION. FULL SCALE TESTS SUBSTANTIATED THESE CONCLUSIONS, THEREFORE A TOXICITY COMPENSATION FACTOR MUST BE INTRODUCED INTO DESIGN EQUATIONS FOR WASTE STABILIZATION PONDS RECEIVING TOXIC ORGANICS. (LOWRY-TEXAS)

DEVELOPMENT OF A SYMBIOTIC ALGAL-BACTERIAL SYSTEM FOR NUTRIENT REMOVAL FROM WASTEWATER.
HUMENIK, F. J.; HANNA, G. P., JR.
OHIO STATE UNIV., COLUMBUS. DEPT. OF CIVIL ENGINEERING.
24TH ANNUAL PURDUE INDUSTRIAL WASTE CONFERENCE, MAY 6-8, PURDUE UNIVERSITY, LAFAYETTE, INDIANA, 1969.
16 P, 7 FIG, 1 TAB, 15 REF.
*CHLORELLA PYRENOIDOSA, SYNTHETIC SEWAGE FEED, SYMBIOTIC RELATIONSHIPS.
05D
AN ALGAL-BACTERIAL CULTURE, DEVELOPED BY INOCULATION OF WASTEWATER WITH CHLORELLA PYRENOIDOSA, PROVED TO BE EFFICIENT IN REMOVING CERTAIN NUTRIENTS FROM THE EFFLUENTS. UNDER OPTIMUM CONDITIONS, THE ALGAL-BACTERIAL FLOC SETTLED VERY RAPIDLY, YIELDING A CLEAR SUPERNAUT. THE AVERAGE REMOVAL OF PHOSPHATES, HOWEVER, WAS LESS THAN 3%. MAXIMUM REMOVAL OF CHEMICAL OXYGEN DEMAND AND ORGANIC NITROGEN WAS OBTAINED DURING UNAERATED OPERATION WITH HARVESTING. THE BIOMASS OXIDATION REQUIRED 1.27 MILLIGRAMS OF OXYGEN/MILLIGRAM OF SOLIDS. SUPPLEMENTAL AERATION FAILED TO IMPROVE EITHER REMOVAL OR CONSERVATION OF NUTRIENTS. THE TERM 'SYMBIOTIC CULTURE' WAS INTRODUCED ON THE BASIS OF A STEADY-STATE EQUILIBRIUM IN THE OXYGEN CONCENTRATION, MAINTAINED BY PHOTOSYNTHETIC OXYGENATION AND TOTAL RESPIRATION.

ANALYSIS OF THE CONTROL AND PERFORMANCE OF ALGAL-WASTEWATER STABILIZATION PONDS
INCROPERA, F. P.
PURDUE UNIV., LAFAYETTE, IN. SCHOOL OF MECHANICAL ENGINEERING.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-285 709, IN PAPER COPY, IN MICROFICHE. PURDUE UNIVERSITY WATER RESOURCES RESEARCH CENTER, TECHNICAL REPORT NO. 104. SEPTEMBER 1978. 77 P, 36 FIG, 59 REF. OWRT-A-42-IND(4).
FIELD 05D
THERE HAS BEEN CONSIDERABLE INTEREST IN RECENT YEARS IN CONTROLLING THE THERMAL CONDITION OF SHALLOW WATER BODIES USED TO EFFECT BENEFICIAL BIOLOGICAL CONVERSION PROCESSES. WASTE HEAT FROM A POWER PRODUCTION PROCESS MAY BE USED AS THE ENERGY SOURCE FOR THIS CONTROL, AND SPECIFIC APPLICATIONS INCLUDE WASTEWATER TREATMENT AND ALGAL PRODUCTION. IN THIS STUDY MATHEMATICAL MODELS WERE DEVELOPED TO ASSESS MEANS OF MAINTAINING THERMAL CONTROL AND ASSESSING THE IMPACT ON WASTEWATER TREATMENT AND ALGAL PRODUCTION. THE THERMAL RESPONSE AND CONTROL OF A SHALLOW POND WHICH USES WASTE HEAT IN A CLOSED CYCLE COOLING SYSTEM WAS CONSIDERED. CALCULATIONS SUGGESTED A HEAT EXCHANGER DESIGN INVOLVING A NETWORK OF 30M LONG, 25MM OD PIPES ON 0.15M CENTERS. THE DESIGN PROVIDES A REASONABLE COMPROMISE BETWEEN INITIAL COST AND PERFORMANCE AND ENABLES MAINTAINING NEAR-OPTIMUM POND TEMPERATURES THROUGHOUT THE YEAR FOR CLIMATIC CONDITIONS TYPICAL OF THE MIDWEST. CALCULATIONS BASED ON A MODEL OF A COMPLETELY MIXED ACTIVATED SLUDGE WASTEWATER TREATMENT SYSTEM REVEALED THE BENEFITS TO BE DERIVED FROM OPERATION AT ELEVATED TEMPERATURES. EFFLUENT QUALITY IS IMPROVED FOR ANY INCREASE IN TEMPERATURE FROM 10 TO 30 DEG. C. CALCULATIONS BASED ON A MODEL OF ALGAL GROWTH AT OPTIMUM TEMPERATURES PREDICTED DAILY YIELDS WHICH ARE IN AGREEMENT WITH MAXIMUM YIELDS WHICH HAVE EITHER BEEN MEASURED OR INFERRED FROM FIELD STUDIES.

A MODEL FOR OXYGEN AND BIOMASS PRODUCTION IN A MASS ALGAL CULTURE.
INCROPERA, F. P.; THOMAS, J. F.
PURDUE UNIV., LAFAYETTE, IND. SCHOOL OF MECHANICAL ENGINEERING.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-264 100, IN PAPER COPY, IN MICROFICHE. PURDUE UNIVERSITY WATER RESOURCES RESEARCH CENTER, TECHNICAL REPORT NO. 84, JANUARY 1977. 74 P, 29 FIG, 2 TAB, 35 REF. OWRT A-042-IND(1).
*RADIATION ABSORPTION, *BIOMASS PRODUCTION, INSOLATION, OXYGEN PRODUCTION, INDIANAPOLIS(IND), *MASS ALGAL CULTURES.
05D
THE PRIMARY PURPOSE WAS TO DEVELOP A MODEL FOR A RELIABLE METHOD OF PREDICTING THE YIELD OF A MASS CULTURE OF UNICELLUAR ALGAE IN WASTEWATER TREATMENT PONDS. SUCH ALGAL CULTURES ARE CAPABLE OF PRODUCING A HIGH PROTEIN FOOD SUPPLEMENT. THE MODEL DEVELOPED DETERMINES BOTH OXYGEN AND ALGAL BIOMASS PRODUCTION AND IS BASED UPON THE USE OF AVAILABLE INSOLATION DATA. IT ACCOUNTS FOR SPECTRAL EFFECTS IN THE PHOTOSYNTHETICALLY ACTIVE REGION, AS WELL AS DIRECTIONAL EFFECTS THROUGH DELINEATION OF THE DIFFUSE AND COLLIMATED COMPONENTS OF THE RADIATION. THE EFFECTS OF THE AIR-WATER INTERFACE ARE TREATED, AND PREDICTIONS OF THE RADIATION FIELD WITHIN THE WATER ARE USED WITH A REPRESENTATIVE PHOTOSYNTHESIS MODEL TO PREDICT THE HOURLY YIELD. CALCULATIONS HAVE BEEN PERFORMED FOR THE INDIANAPOLIS, INDIANA REGION, AND COMPARISONS WITH FIELD DATA FOR SIMILAR LATITUDES REVEAL THAT THE MODEL IS WELL SUITED FOR PREDICTING THE MAXIMUM YIELD OF MASS CULTURES.

RATIONAL PROCESS DESIGN STANDARDS FOR AEROBIC OXIDATION PONDS IN AHMEDABAD, INDIA.
JAYANGOUDAR, I. S.; KOTHANDARAMAN, V.; THERGAONKAR, V. P.; SHAIK, S. G.
CENTRAL PUBLIC HEALTH ENGINEERING RESEARCH INST., AHMEDABAD (INDIA). FIELD CENTRE.
JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 42, NO 8, P 1501-1514, AUGUST 1970. 7 TAB, 22 REF.
*AHMEDABAD(INDIA).
05D;05G
IN THE DESIGN OF AEROBIC PONDS BASED ON MAXIMUM ALGAL PRODUCTION CONSIDERING A TOTAL BOD DESIGN LOAD, THE PRIMARY FACTORS INVOLVED ARE THE OPERATING TEMPERATURES, ALGAL COMPOSITION OR UNIT HEAT OF COMBUSTION, SOLAR RADIATION CORRECTED TO SKY CLEARANCE FACTOR, AND PHOTOSYNTHETIC EFFICIENCY. EXPERIMENTAL RESULTS AND SOLAR RADIATION DATA FROM AHMEDABAD, INDIA, WERE USED TO CALCULATE THE FOLLOWING: (1) THE ULTIMATE INFLUENT AND EFFLUENT BOD; (2) THE TOTAL QUANTITY OF OXYGEN THAT MUST BE PRODUCED FOR BOD SATISFACTION; (3) THE QUANTITY OF ALGAE THAT MUST BE PRODUCED TO LIBERATE THE REQUIRED OXYGEN; (4) THE TOTAL ENERGY REQUIRED TO SUSTAIN ALGAL GROWTH; (5) THE SOLAR RADIATION AVAILABLE AT AHMEDABAD; AND (6) THE QUANTITY OF ENERGY STORED IN THE ALGAL CELLS AT 6% LIGHT CONVERSION EFFICIENCY. FROM THESE RESULTS, THE PROCESS DESIGN STANDARDS FOR OXIDATION PONDS IN AHMEDABAD WERE WORKED OUT FOR THE FOUR SEASONS OF 1962-63 AND WERE SUMMARIZED IN TABLES. (MURPHY-TEXAS)

OZONIZATION OF EFFLUENTS OF A KRAFT PULP MILL (OZONIROVANIE STOCHNYKH VOD SUL'FATNO-TSELLYULOZNOGO PROIZVODSTVA).
KARELIN, YA. A.; SALAMATOV, YU. P.
MOSKOVSKII INZHENERNO-STROITELNYI INSTITUT (USSR).
IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENII STROITEL'STUVO I ARKHITEKTURA, VOL 16, NO 7, P 136-141, 1973. 1 FIG, 6 REF, 3 TAB.
ALUMINA, POLYACRYLAMIDE, KRAFT MILLS, SOVIET UNION(USSR), BAIKAL KRAFT MILL.
OZONIZATION AS AN ADDITIONAL MEANS OF EFFLUENT PURIFICATION WAS STUDIED ON EFFLUENTS OF THE BAIKAL KRAFT MILL PRODUCING VISCOSE-GRADE BLEACHED KRAFT PULP. THE EFFLUENT PURIFICATION SYSTEM AT THE MILL INCLUDES 4 STAGES, VIZ., BIOCHEMICAL PURIFICATION, COAGULATION WITH ALUMINA OR POLYACRYLAMIDE, MECHANICAL TREATMENT (SAND FILTER, SEDIMENTATION POND), AND SATURATION WITH OXYGEN IN AN AERATION POND. THE PROCESS REDUCED 5-DAY BOD TO 6-8 MG/LITER, COD TO 100-150 MG/LITER, THE SUSPENDED SOLIDS CONTENT TO 8-10 MG/LITER, AND THE COLOR INDEX TO 80-100. THIS IS CONSIDERED INSUFFICIENT. OZONIZATION EXPERIMENTS, CARRIED OUT UNDER LABORATORY CONDITIONS, WERE AIMED AT DETERMINING WHETHER FURTHER PURIFICATION COULD BE ACHIEVED, ESPECIALLY THE REMOVAL OF SULFUR COMPOUNDS AND PHENOLS, EVEN UNDER STATIONARY CONDITIONS. OZONIZATION WAS FOUND TO BE EFFECTIVE IN INCREASING THE DEGREE OF PURIFITY OF BIOLOGICALLY TREATED EFFLUENT AND OF THE EVAPORATION CONDENSATE. OZOINZATION UNDER DYNAMIC CONDITIONS (IN A BUBBLING COLUMN) AND HIGHER OZONE CONCENTRATIONS (UP TO 120 MG/LITER) GAVE A 65% REDUCTION IN COD OF THE BIOLOGICALLY PURIFIED EFFLUENT, ENTIRELY ELIMINATED SULFUR COMPOUNDS AND PHENOLS FROM THE EVAPORATION CONDENSATE, AND REDUCED THE COD OF EFFLUENT FROM THE FILTRATION STAGE BY 80%. CONSEQUENTLY, OZONIZATION COULD ELIMINATE THE COAGULATION STAGE AFTER BIOCHEMICAL PURIFICATION, AND GIVE THE POSSIBILITY OF RECYCLING THE EVAPORATION CONDENSATE. (STAPINSKI-IPC)

CARBON LIMITATION IN SEWAGE LAGOONS.
KING, D. L.
MISSOURI UNIV., COLUMBIA. DEPT. OF CIVIL ENGINEERING.
IN: NUTRIENTS AND EUTROPHICATION: THE LIMITING NUTRIENT CONTROVERSY, P 98-110, 8 FIG, 16 REF, AMERICAN SOCIETY OF LIMNOLOGY AND OCEANOGRAPHY SPECIAL SYMPOSIA VOL 1, ALLEN PRESS, LAWRENCE, KANSAS, 1972.
*LIMITING NUTRIENTS.
05C
OBSERVATIONS OF SEWAGE LAGOONS OFFER SIGNIFICANT INSIGHT INTO THE PROCESSES INVOLVED IN LAKE EUTROPHICATION. IT IS CONCLUDED THAT BOTH THE QUALITATIVE AND QUANTITATIVE ASPECTS OF EUTROPHICATION MUST BE CONSIDERED. ADDITIONS OF REQUIRED ALGAL NUTRIENTS TO A LAKE ALLOW INCREASES IN QUANTITY OF ALGAE AND CAN STRAIN THE CARBON AVAILABILITY TO THE POINT WHERE THERE IS ALSO A CHANGE IN ALGAL QUALITY. ESTABLISHMENT OF SUMMER BLUE-GREEN ALGAL BLOOMS USUALLY IS OF GREATER CONCERN THAN THE PRECURSORY INCREASE IN QUANTITY OF THE MORE DESIRABLE ALGAL FORMS. CALCULATIONS SUGGEST THAT AMOUNTS OF ALGAL NUTRIENTS, OTHER THAN CARBON, REQUIRED TO PROMOTE SUMMER BLOOMS OF BLUE-GREEN ALGAE ARE DETERMINED BY ALKALINITY OF THE WATER IN QUESTION. ATTEMPTS TO CONTROL EUTROPHICATION BY LIMITING JUST CARBON AVAILABILITY PROBABLY WOULD RESULT IN ESTABLISHMENT OF BLUE-GREEN ALGAE DOMINANCE BUT PERHAPS IN LOWER QUANTITIES. THE BLUE-GREEN ALGAE PROBABLY WOULD ACCELERATE AND RATE OF CARBON DIOXIDE GAIN FROM THE ATMOSPHERE. ATTEMPTS TO LIMIT AVAILABLE NITROGEN MAY RESULT IN ESTABLISHMENT OF BLOOMS BLUE-GREENS WHICH CAN FIX ATMOSPHERIC NITROGEN. LIMITATION OF PHOSPHORUS APPEARS TO OFFER THE BEST CHANCE OF CONTROLLING BOTH QUALITATIVE AND QUANTITATIVE ASPECTS OF EUTROPHICATION.

EFFECT OF LAGOON EFFLUENT ON A RECEIVING STREAM.
KING, DARRELL L.; TOLMSOFF, ALLEN J.; ATHERTON, MICHAEL J.
MISSOURI UNIV., COLUMBIA.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 159-167, 5 FIG, 4 TAB, 3 REF.
*RIFFLES, *CALORIC CONTENT.
05D;05C
BEAR CREEK, A SMALL STREAM WHOSE FLOW IS 21.5% LAGOON EFFLUENT AND SEEPAGE, WAS THE SITE OF A 90 DAY STUDY WHICH ATTEMPTED TO DETERMINE WHAT STREAM PARAMETERS OR CHARACTERISTICS WERE ALTERED BY LAGOON EFFLUENT. PARAMETERS MONITORED WERE, BOD, COD, AND ALSO VOLATILE, SUSPENDED, AND OTHER SOLIDS MEASUREMENTS. THE OXYGEN DEMANDS OF THE VARIOUS CONSTITUENTS WERE THEN CALCULATED AND ANALYZED. FROM THESE EXPERIMENTS, IT WAS DETERMINED THAT RECEIVING STREAMS FOR ALGAE-LADEN EFFLUENTS CAN BE SIGNIFICANTLY INFLUENCED FROM SEVERAL FEET TO SEVERAL MILES DOWNSTREAM. THE AMOUNT OF FLOW IN THE STREAM, AND THE RIFFLE-POOL RATIO WERE FOUND TO BE THE FACTORS WHICH DETERMINE THE DISTANCE DOWNSTREAM WHICH A STREAM WILL BE AFFECTED. SMALLER STREAMS MAY BE BROKEN DOWN INTO RIFFLES, WHICH ACT MUCH LIKE TRICKLING FILTERS, AND POOLS, WHICH ARE MERELY SEDIMENTATION AND DIGESTION UNITS. A MAJOR POINT OF THESE EXPERIMENTS WAS DEMONSTRATION OF THE FACT THAT THE RECEIVING STREAM, IN MANY CASES, IS AN INTEGRAL PART OF THE TREATMENT FACILITY AND MUST BE CONSIDERED AS SUCH BEFORE THE TOTAL SYSTEM CAN BE EVALUATED.

INTERACTING ENVIRONMENTAL FACTORS WHICH CONTROL THE SINKING RATE OF PLANKTONIC ALGAE
KING, D. L.; HILL, M. T.
MICHIGAN STATE UNIV., EAST LANSING. DEPT. OF FISHERIES AND WILDLIFE.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-286 070, IN PAPER COPY, IN MICROFICHE. COMPLETION REPORT JULY, 1978. 40 P, 12 FIG, 1 TAB, 35 REF, APPEND. OWRT A-090-MICH(1), 14-31-0001-7040.
FIELD 05C, 05A
LIGHT AND CARBON DIOXIDE LIMITS INTERACT IN A MULTIPLICATIVE FASHION TO CONTROL THE SPECIFIC GROWTH RATE, THE SPECIFIC SINK RATE AND THE SPECIFIC PLANKTON BIOMASS ACCUMULATION RATE OF CHLORELLA VULGARIS. UG DECREASES, US INCREASES AND UAB DECREASES AS FUNCTIONS OF INCREASED STRESS ON THE ALGA INDUCED BY INTERACTIONS BETWEEN CARBON AND LIGHT. THE EFFECT OF THE DECREASE IN UAB AS A FUNCTION OF THE INTERACTING LIMITS IS TO LIMIT THE ABILITY OF CHLORELLA VULGARIS TO COMPETE IN NATURAL SYSTEMS AT FREE CARBON DIOXIDE CONCENTRATIONS THREE ORDERS OF MAGNITUDE GREATER THAN THOSE REQUIRED TO SUSTAIN PHOTOSYNTHETIC CARBON FIXATION. THIS SUGGESTS THAT APPLICATION OF RESULTS FROM CHEMOSTAT STUDIES OF PLANKTON ALGAL KINETIC RESPONSE TO ENVIRONMENTAL LIMITS INCORPORATES A SIGNIFICANT ERROR ASSOCIATED WITH THE SINKING OF ALGAE IN NATURAL SYSTEMS. APPLICATION OF THESE RESULTS TO ALGAL BIOASSAYS, LAKE EUTROPHICATION, SEWAGE LAGOONS AND AQUACULTURE ARE DISCUSSED.

SEQUENTIAL PROCESSING IN WASTEWATER LAGOONS.
KLOCK, J. W.
ARIZONA STATE UNIV., TEMPE.
JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 44, NO 2, FEBRUARY 1972, P 241-254, 12 FIG, 3 TAB, 5 REF.
05D
A RELIABLE AND SIMPLY OPERATED LAGOON, INCORPORATING THE PRINCIPLES OF HEAT CONSERVATION, SEQUENTIAL-PHASE PROCESSING, AND UTILIZATION OF THIN PLASTIC FILMS TO FORM CHANNEL BARRIERS AND HEAT TRANSFER SURFACES, WAS DEVELOPED. THE CONSTRUCTION OF THE SYSTEM INCLUDED THE USE OF CHANNELS CONSTRUCTED OF BLACK POLYETHYLENE SHEETS. THE INFLUENT TO THE SYSTEM FLOWED INTO THE LAGOON IN THE LOWER PHASE I, AND THE PHASE II CHANNELS OF THE BLACK POLYETHYLENE FLOATED ON THE SURFACE OF THE PHASE I LIQUID. THIS ARRANGEMENT EFFECTIVELY PREVENTED HEAT LOSS DIRECTLY TO THE ATMOSPHERE ABOVE THE PHASE I LIQUID, AND THE THIN PLASTIC MATERIAL ALLOWED HEAT EXCHANGE FROM THE LOWER PHASE TO THE UPPER PHASE. PHASE I WAS DESIGNED AS STRICTLY A BACTERIAL PHASE TO PREVENT PREMATURE ALGAE GROWTH AND SUBSEQUENT NUTRIENT FIXATION, WITH PHASE II INTENDED AS AN ALGAL PHASE FOLLOWED BY LIMITED GROWTH OF CRUSTACEANS AND AQUATIC INSECTS. AVERAGE BOD REDUCTION WAS 76.8%, WITH MINIMAL SURFACE SOLIDS AND NO ODORS. ASSOCIATED OPERATIONAL PROBLEMS AND SOLUTIONS ARE PRESENTED. (LOWRY-TEXAS)

CHLORINATION DYNAMICS IN WASTEWATER EFFLUENTS.
KOTT, YEHUDA
TECHION - ISRAEL INST. OF TECH., HAIFA (ISRAEL). SANITARY ENGINEERING LAB.

JOURNAL OF THE SANITARY ENGINEERING DIVISION, PROCEEDINGS OF ASCE, VOL 97, NO SA 5, OCTOBER 1971, P 647-655, 2 FIG, 10 TAB, 17 REF.
*CYSTS, ISRAEL.
05D
THE RESPONSE OF COLIFORMS, ENDAMOEBA HISTOLYTICA CYSTS, AND ALGAE TO CHLORINATION WAS INVESTIGATED ON A LABORATORY SCALE. EFFLUENT USED WAS OBTAINED FROM A TRICKLING FILTER PLANT, AND FROM AN ARTIFICIAL OXIDATION POND. APPLICATION OF 8 MG/L OF CHLORINE TO THE TRICKLING FILTER EFFLUENT REDUCED THE COLIFORM COUNT FROM 10 TO THE 7TH POWER ORGANISMS PER 100 ML TO LESS THAN 100 ORGANISMS PER 100 ML. APPLICATION OF 14 MG/L ACTUALLY PRODUCED A GREATER NUMBER OF COLIFORM ORGANISMS IN THE EFFLUENT THAN WAS NOTICED FOR THE 8 MG/L DOSAGE. THE PROBABLE CAUSE WAS ASSUMED TO BE THE BREAK-DOWN OF ORGANIC MATERIAL AND RELEASE OF ENTRAPPED COLIFORM ORGANISMS. APPLICATION OF THE 8 MG/L DOSAGE TO SOLUTIONS CONTAINING THE ENDAMOEBA HISTOLYTICA CYSTS ALSO PRODUCED A RAPID AND THOROUGH KILL, ALTHOUGH THE DEATH RATE WAS QUITE TEMPERATURE DEPENDENT. ALGAE WAS UNAFFECTED FOR A TWO HOUR INTERVAL, EXCEPT FOR THE CESSATION OF GROWTH. SINCE THE CHLORINE DID NOT ATTACK THE ALGAE FOR 2 HOURS, MUCH LONGER THAN THE NORMAL CONTACT TIME, THEN, CHLORINATION SHOULD BE WELL SUITED FOR DISINFECTION OF OXIDATION POND EFFLUENT.

PRODUCTIVITY OF CLARIAS BATRACHUS IN THE SEWAGE FERTILIZED FISH PONDS.
KRISHNAMOORTHI, K. P.; ABDULAPPA, M. K.; RAO, A. V. J.
NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INST., NAGPUR (INDIA).
INDIAN JOURNAL OF ENVIRONMENTAL HEALTH, VOL 18, NO 4, P 292-298, OCTOBER, 1976, 6 FIG, 5 REF.
05C;C8I
TWO FISH PONDS, FERTILIZED WITH STABILIZATION POND EFFLUENT, WERE STOCKED WITH CLARIAS BATRACHUS TO REDUCE FISHKILL FROM SEASONAL ALGAL BLOOMING. A STUDY WAS CONDUCTED TO DETERMINE C. BATRACHUS GROWTH, AS WELL AS RELATED CHEMICAL AND BIOLOGICAL PARAMETERS. OVER A TWO-YEAR PERIOD THE FISH PONDS WERE 20-30 C, AND PH RANGED FROM 7 TO 9.5. OBSERVED PH FLUCTUATIONS RESULTED FROM HIGH PHOTOSYNTHETIC ACTIVITY AND COMMUNITY RESPIRATION. C. BATRACHUS WERE ABLE TO SURVIVE EXTREME ENVIRONMENTAL CONDITIONS AND AMMONIA TOXICITY CREATED AT HIGH PH VALUES. THE BOD, NITROGEN, AND PHOSPHATE RATIO WAS 60:30:4 INDICATING EXCESSIVE NITROGEN AND ADEQUATE PHOSPHATE CONCENTRATIONS TO SUPPORT A BLOOMING PROPORTION OF ALGAE. INDIAN CATFISH CULTURE IS QUITE YOUNG AND THERE IS NO REGULAR SOURCE OF SUPPLY. IT WAS CONCLUDED THAT LARGE-SCALE CATFISH CULTURE IN PONDS AND SWAMPS RECEIVING SULLAGE, SEWAGE AND TREATMENT PLANT EFFLUENT COULD ENHANCE THE PRODUCTION OF CATFISH AS A FOOD SOURCE. (COLLINS-FIRL)

TERTIARY TREATMENT WITH A CONTROLLED ECOLOGICAL SYSTEM.
LAS VIRGENES MUNICIPAL WATER DISTRICT, CALABASAS, CALIF.
COPY AVAILABLE FROM GPO SUP DOC AS EPI.23:660/2-73-022 $0.90; MICROFICHE FROM NTIS AS PB-231261 $1.45.
ENVIRONMENTAL PROTECTION AGENCY TECHNOLOGY SERIES REPORT EPA-660/2-73-022, DECEMBER 1973. 43 P, 21 FIG, 6 TAB, 3 REF. EPA PROJECT 16080 FUH.
BIOLOGICAL PROCESSES, POLISHING(TREATMENT).
05D;C5G
A TWO-STAGE POND SYSTEM WAS OPERATED AS A PROCESS FOR POLISHING SECONDARY SEWAGE EFFLUENT. THE SHALLOW FIRST STAGE WAS AN OXIDATION POND IN WHICH A HEAVY GROWTH OF ALGAE WAS PERMITTED TO DEVELOPE. IN THE SECOND STAGE A POPULATION OF DAPHNIA PULEX CONSUMED THE ALGAE. DETENTION TIMES WERE ABOUT 10 DAYS IN EACH STAGE. CHEMICAL AND BIOLOGICAL MONITORING WERE CARRIED OUT OVER A YEAR'S PERIOD TO DETERMINE FEASIBILITY OF USING THE PROCESS TO PRODUCE RECREATIONAL-GRADE WATER AND REDUCE ALGAE GROWTH POTENTIAL. WHILE THE DAPHNIA REMAINED AS THE DOMINANT ZOOPLANKTON SPECIES IN THE SECOND POND THROUGHOUT THE OBSERVATION PERIOD, THEIR CONCENTRATION VARIED BETWEEN 100 AND 1,500 ORGANISMS/LITER. EXCELLENT WATER CLARITY WAS OBTAINED WHEN THE DAPHNIA WERE ABOVE 500 ORGANISMS/LITER, AND AT SUCH TIMES THE OVER-ALL COD REDUCTION WAS GREATER THAN 40 PERCENT. SIGNIFICANT REMOVAL OF NUTRIENTS OCCURRED ONLY DURING THE MONTHS OF JULY AND AUGUST, WHEN N AND P REDUCTIONS WERE 48 PERCENT AND 63 PERCENT RESPECTIVELY. PERFORMANCE WAS HAMPERED BY OCCASIONAL INVASIONS OF DAPHNIA OR ROTIFERS IN THE FIRST-STAGE POND, WHICH DECIMATED THE ALGAE. SUCH EVENTS WERE NOT SUCCESSFULLY CONTROLLED AND REMAIN THE PRINCIPAL OBSTACLE TO FURTHER PROCESS DEVELOPMENT. (EPA)

AEROBIC LAGOON WASTE TREATMENT AND METHOD.
LE COMPTE, A. R., JR.; APPEL, D. W.
KIMBERLY-CLARK CORP., NEENAH, WIS. (ASSIGNEE).
UNITED STATES PATENT NO. 3,893,924, JULY 8, 1975, 9 P, 5 FIG, 6 CLAIMS.
5D
A SYSTEM FOR TREATING LIQUIDS CONTAINING WASTE MATERIALS, SUCH AS PAPER MILL EFFLUENTS, INCLUDES A

BASIN OR LAGOON WHICH IS OPERATED AEROBICALLY BY THE USE OF JETS ARRANGED SO AS TO SET UP CELLS OF COMPLEMENTARY PRIMARY CIRCULATION WITH RESULTING SECONDARY CIRCULATION PATTERNS SUFFICIENT TO PREVENT SOLIDS FROM SETTLING OUT, EXCEPT WHEN DESIRED IN A SETTLING ZONE. POWER REQUIREMENTS ARE REDUCED AS COMPARED TO THOSE OF CONVENTIONAL SURFACE-AERATED OR DIFFUSER-AERATED LAGOONS EQUIPPED TO OPERATE AEROBICALLY. (LYNCH-IPC)

AERATED LAGOON TREATMENT OF BLEACHED KRAFT MILL EFFLUENTS AT HIGH TEMPERATURE
LEE, E. G.-H.; MUELLER, J. C.; WALDEN, C. C.
BRITISH COLUMBIA RESEARCH COUNCIL, VANCOUVER.
CANADIAN PULP AND PAPER ASSOCIATION, TRANSACTIONS OF THE TECHNICAL SECTION, VOL. 4, NO. 1, P TR15-TR18, MARCH, 1978. 4 FIG, 12 REF, 6 TAB.
FIELD 05D
LABORATORY STUDIES SUGGEST THAT AERATED LAGOONS FOR TREATING BLEACHED KRAFT MILL EFFLUENTS PERFORM SATISFACTORILY UP TO ABOUT 45-50 C. FIVE-DAY BOD REMOVAL AND DETOXIFICATION EFFICIENCY BEGIN TO DROP WHEN TEMPERATURES EXCEED 50 C. THE TENDENCY OF MIXED LIQUOR SUSPENDED SOLIDS (BIOMASS) TO DISPERSE ALSO INCREASES AT TEMPERATURES ABOVE 50 C, RESULTING IN POOR SLUDGE SETTLEABILITY, SLUDGE WASHOUT, AND HIGH SUSPENDED SOLIDS LEVELS IN EFFLUENTS. (SWITCHENBERG-IPC)

REVIEW OF EPA RESEARCH AND DEVELOPMENT LAGOON UPGRADING PROGRAM FOR FISCAL YEARS 1973, 1974, AND 1975.
LEWIS, R. F.
NATIONAL ENVIRONMENTAL RESEARCH CENTER, CINCINNATI, OHIO. ADVANCED WATER TREATMENT RESEARCH LAB.
IN: UPGRADING WASTEWATER STABILIZATION PONDS TO MEET NEW DISCHARGE STANDARDS, AUGUST 21-23, 1974, LOGAN, UTAH, UTAH STATE UNIVERSITY, P 3-14, 14 FIG, 5 TAB, 7 REF.
TERTIARY LAGOONS, FACULTATIVE LAGOONS.
05D;05G
THE ENVIRONMENTAL PROTECTION AGENCY RESEARCH AND DEVELOPMENT PROGRAM FOR UPGRADING THE PERFORMANCE OF LAGOON WASTE WATER TREATMENT SYSTEMS IS REVIEWED. APPROXIMATELY 90% OF ALL OF THE WASTE WATER LAGOONS IN THE UNITED STATES ARE LOCATED IN COMMUNITIES OF 10,000 PEOPLE OR LESS. THEREFORE, VERY LITTLE MONITORING OR ANALYSIS OF INFLUENTS OR EFFLUENTS TAKES PLACE. A COMPREHENSIVE SURVEY TAKEN OF LAGOONS ALL ACROSS THE COUNTRY EVALUATED BIOCHEMICAL OXYGEN DEMAND AND SUSPENDED SOLIDS FOR FACULTATIVE LAGOONS, AERATED LAGOONS, OXIDATION DITCHES, AND TERTIARY LAGOONS. THE EPA AND ITS PREDECESSOR ORGANIZATIONS HAVE SPONSORED SEVERAL MEETINGS AND RESEARCH PROJECTS ON THE GENERAL TOPIC OF WASTE WATER LAGOONS AND IN A FEW CASES ON MEANS OF UPGRADING LAGOONS. A VIGOROUS LAGOON UPGRADING PROGRAM HAS BEEN SPURRED BY THE PASSAGE OF NEW STANDARDS FOR EFFLUENT BOD AND SUSPENDED SOLIDS. RESEARCH NEEDS FOR LAGOON UPGRADING, WHICH HAVE BEEN IDENTIFIED BY A VARIETY OF STATE, ACADEMIC AND PRIVATE GROUPS, ARE PRESENTED. PROJECTS FOR FISCAL YEAR 1973 INCLUDED THE REMOVAL OF ALGAE FROM LAGOON EFFLUENTS AND A REVISION OF THE MANUAL ON ALGAE AND WATER POLLUTION. PROJECTS FOR 1974 WERE ON THE PERFORMANCE OF EVALUATING EXISTING FACULTATIVE LAGOONS AND THE LAGOON WORKSHOP SYMPOSIUM. PROJECTS THAT WERE PLANNED FOR FISCAL YEAR 1975 INCLUDE A CHLORINE DISINFECTION STUDY, THE NITRIFICATION OF LAGOON EFFLUENT WITH A ROTATING BIOLOGICAL CONTACTOR, AND COMBINED NITROGEN AND PHOSPHORUS CONTROL IN A LAGOON. A SUMMARY OF FUNDING FOR LAGOON UPGRADING PROJECTS IS GIVEN. IT IS HOPED THAT FUNDS WILL SOON BE AVAILABLE TO STUDY WELL-DESIGNED AERATED LAGOONS AND AERATED/FACULTATIVE LAGOON COMBINATIONS.

95% BOD REMOVAL RESULT OF FRUIT PLANT MODIFICATIONS.
LISANTI, A. F.; BALAKRISHNAN, S.
CHESTER ENGINEERS, INC., CORPOLIS, PA.
WATER AND WASTE ENGINEERING, VOL 11, NO 3, P 81-82, 84, 86, MARCH, 1974, 11 FIG, 5 TAB.
05D
COMSTOCK FOODS, A DIVISION OF BORDEN, INCORPORATED, HAS BUILT A NEW PLANT AT A COST OF $300,000 AT RED CREEK, NEW YORK, ON A 50-ACRE SITE. PROCESSING AND PACKING OF APPLE AND CHERRY CROPS CONSTITUTE THE BULK OF THE TOTAL PLANT PRODUCTION, AND WASTES DERIVE FROM WASHING, PEELING, PITTING, SLICING AND CLEAN UP OPERATIONS. THE OLD WASTE TREATMENT FACILITIES CONSISTED OF FOUR CONVENTIONAL ANAEROBIC LAGOONS IN SERIES. THEY WERE RESHAPED AND MODIFIED TO FORM PART OF THE NEW SYSTEM IN THE FOLLOWING WAYS: LAGOON I WAS REDUCED IN SIZE TO PROVIDE ABOUT ONE DAY'S DETENTION AND TO SERVE AS THE RAW WASTE EQUALIZATION LAGOON; LAGOON II HAD ITS SIDES AND BOTTOM RESLOPED TO PROVIDE A LIQUID DEPTH OF TEN FEET AND RIP RAP AT THE WATER LINE, AND TO SERVICE AS THE AERATED LAGOON; LAGOONS III AND IV WERE DEEPENED AND RESHAPED TO ALLOW FOR RETENTION OF THE TREATED EFFLUENT DURING DRY WEATHER. IN ADDITION TO THESE MODIFICATIONS AN INTERCEPT DRAINAGE TRENCH WAS PROVIDED AROUND THE LAGOONS TO PREVENT ANY RUNOFF FROM ADJACENT FIELDS FROM DRAINING INTO RED CREEK. THE OLD WASTE WATER COLLECTION, PUMPING AND SCREENING SYSTEMS WERE

COMPLETELY REBUILT TO HANDLE THE FLOW AND MORE EFFECTIVELY REMOVE SOLIDS. WHENEVER A DISCHARGE FROM LAGOON IV IS MADE, EIGHT-HOUR COMPOSITE SAMPLES ARE TAKEN AND ANALYZED FOR BOD5 AND SUSPENDED SOLIDS. AVERAGE BOD5 REMOVALS ACROSS THE AERATED LAGOON AND THE ENTIRE TREATMENT SYSTEM ARE 83% AND 96%, RESPECTIVELY. (MURPHY-FIRL)

REMOVAL OF PHOSPHOROUS FROM A SEWAGE LAGOON BY HARVESTING ALGA.
LITTLE, J. E.
MISSISSIPPI STATE UNIV., STATE COLLEGE. DEPT. OF CIVIL ENGINEERING.
MASTER'S THESIS, AUGUST 1969. 41 P, 11 FIG, 2 TAB, 30 REF.
05D;05C
EUTROPHICATION, DEFINED AS THE PROCESS IN WHICH SURFACE BODIES OF WATER ARE ENRICHED BY THE EXCESSIVE ADDITION OF NUTRIENTS, AFFECTS AS MUCH AS 56% OF TOTAL MUNICIPAL SURFACE WATER SUPPLIES IN THE UNITED STATES. EXCESSIVE ALGAL GROWTH IN EUTROPHIED WATER CAUSED DIFFICULTIES IN TREATING SEWAGE AND REDUCED THE RECREATION VALUE OF LAKES AND STREAMS. BECAUSE EUTROPHICATION IS A PRODUCT OF NUTRIENT ENRICHMENT, IT WAS DECIDED THAT CONTROL MEASURES SHOULD BE BASED ON EITHER REMOVAL, REDUCTION, OR PREVENTION OF THE ADDITION OF NUTRIENTS. MAKING USE OF THE SEWAGE LAGOON RESEARCH FACILITY AT MISSISSIPPI STATE UNIVERSITY, AN ATTEMPT WAS MADE TO SEE WHETHER THE PHOSPHOROUS CONTENT OF AN OXIDATION POND EFFLUENT COULD BE BROUGHT TO ACCEPTABLE LEVELS THROUGH HARVESTING THE ALGAE CONTAINED IN THE POND EFFLUENT. A SIX MONTH STUDY REVEALED THAT: (1) HARVESTING ALGAE REDUCED THE PHOSPHATE CONCENTRATION TO 91% MAXIMUM REMOVAL, (2) HARVESTING ALGAE WILL NOT REMOVE ENOUGH PHOSPHOROUS FROM OXIDATION POND EFFLUENT TO CONTROL ALGAL GROWTHS IN RECEIVING STREAMS AND LAKES UNLESS A LARGE QUANTITY OF ALMOST PHOSPHOROUS-FREE WATER IS AVAILABLE FOR DILUTION. (3) A FILTER WITH A PORE SIZE OF 45 MICRON OR LESS APPEARS TO REMOVE ALL INSOLUBLE PHOSPHATE FROM OXIDATION POND EFFLUENT, BUT ADEQUATE FLOW IS DIFFICULT TO ATTAIN. (4) IT DOES NOT APPEAR THAT THE METHOD STUDIED IS PRACTICAL BECAUSE A SIGNIFICANT DEGREE OF PHOSPHOROUS REMOVAL IS ACHIEVED ONLY WHEN BOD REMOVAL EFFICIENCY IS LOW, THEREBY DEFEATING THE ORIGINAL PURPOSE OF OXIDATION PONDS. (ADKINS-TEXAS)

THE EFFECT OF ALGAL CONCENTRATION, LUMINOUS INTENSITY, TEMPERATURE, AND DIURNAL CYCLE OR PERIODICITY UPON GROWTH OF MIXED ALGAL CULTURES FROM WASTE STABILIZATION LAGOONS AS DETERMINED ON THE WARBURG APPARATUS.
LUEBBERS, R. H.; PARIKH, D. N.
MISSOURI UNIV., COLUMBIA. DEPT. OF CHEMICAL ENGINEERING.
PROCEEDINGS, INDUSTRIAL WASTE CONFERENCE, 21ST, MAY 3-5, 1966. PART 1, P 348-367. 13 FIG, 21 REF.
*OXYGEN PRODUCTION.
05D;05C
THE NORMAL PERFORMANCE AND EFFECT OF VARIOUS OPERATING VARIABLES ON WASTE STABILIZATION LAGOONS WERE INVESTIGATED IN A 2 STAGE EXPERIMENTAL STUDY. THE RESULTS OF THE FIRST STAGE PILOT PLANT STUDY, PARTICULARLY THE EFFECT OF SUPPLEMENTARY LIGHT ON ALGAL GROWTH PROMPTED THE USE OF THE WARBURG APPARATUS. USING SUBSTRATE FROM THE PILOT PLANT LAGOONS, TESTS RUNS WERE MADE BOTH WITH AND WITHOUT A SOURCE OF ACTINIC LIGHT, AND WITH KOH, A 'CARBON DIOXIDE BUFFER', OR NO MATERIAL IN THE CENTER WELL OF THE WARBURG FLASKS. THE STANDARD 5 DAY BOD OCCURRED IN 50 HOURS AND THE NITROGEN PLATEAU AT 350 HOURS. O2 PRODUCTION IS ALMOST A LINEAR FUNCTION OF ALGAL AND OTHER BIOTA CONCENTRATION. O2 PRODUCTION INCREASED AS A LOGARITHMIC FUNCTION OF LIGHT CONCENTRATION UP TO 720 FT-CANDLES, REMAINED CONSTANT UNTIL 4500 FT-CANDLES, AND THEN DECREASED WITH THE ALGAE DYING WITHIN 24 HOURS. O2 PRODUCTION VARIED WITH TEMPERATURE, VERY LOW AT 10 DEG C, INCREASING RATE AT AN INCREASING RATE TO ABOVE 20 DEG C, AND CONTINUES TO INCREASE AT A DECREASING RATE. MAXIMUM RATE OF O2 PRODUCTION IS ABOVE 35 DEG C. O2 CONSUMPTION WITHOUT LIGHT INCREASED LINEARLY WITH TEMPERATURE. BOTH DIURNAL CYCLE AND PERIODICITY EFFECTED O2 PRODUCTION WITH A MAXIMUM RATE OF PRODUCTION OBTAINED WITH A 55 TO 60% PERIODICITY.

DYNAMIC BEHAVIOUR OF OXIDATION PONDS.
MARAIS, G. V. R.
CAPE TOWN UNIV. (SOUTH AFRICA).
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 15-46. 28 FIG, 14 REF, APPEND.
05D
A COMPUTER MODEL OF OXIDATION PONDS STIMULATED INTEREST IN SEVERAL PARAMETERS WHICH WERE NOT PREVIOUSLY CONSIDERED TO BE IMPORTANT. DATA WAS COLLECTED FROM THE WATERS NORTH POND IN LUSAKA, ZAMBIA, AND THEN ANALYZED AND USED TO DEVELOP THE COMPUTER MODEL. THIS MODEL CLEARLY DEMONSTRATED THAT (1) MIXING IN THE POND DEMANDS MUCH GREATER ATTENTION AS AN INFLUENTIAL PARAMETER WITH RESPECT TO BOTH THE THEORETICAL

AND THE PRACTICAL ASPECTS, (2) ADVENT OF ANAEROBIC CONDITIONS IN AEROBIC OXIDATION PONDS IS A MUCH MORE COMPLEX PHENOMENON THAN WAS PREVIOUSLY SUPPOSED, BEING DEPENDENT UPON TEMPERATURE, MIXING, ALGAL GROWTH AND BOD IN THE POND, AND POSSIBLY OTHER PARAMETERS, (3) THE SLUDGE LAYER OCCUPIES AN IMPORTANT POSITION IN THE DEGRADATION PROCESS AND DIRECTS ATTENTION TO THE BENEFITS IN PARTIAL SEPARATION BY ANAEROBIC PRETREATMENT.

INTERMITTENT SAND FILTRATION TO UPGRADE EXISTING WASTEWATER TREATMENT FACILITIES.
MARSHALL, G. R.; MIDDLEBROOKS, E. J.
UTAH CENTER FOR WATER RESOURCES RESEARCH, LOGAN.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE AS PB-231 205; $7.25 IN PAPER COPY, $1.45 IN MICROFICHE. UTAH WATER RESEARCH PUBLICATION PRJEW115-2, FEBRUARY 1974. 80 P, 26 FIG, 34 TAB, 40 REF. OWRR A-015-UTAH(1), 14-01-0001-3845.
INTERMITTENT SAND FILTERS, SLOW SAND FILTERS, *ALGAE REMOVAL, EFFLUENT POLISHING, *SAND FILTERS.
05D
LABORATORY AND FIELD SCALE INTERMITTENT SAND FILTRATION OF WASTEWATER LAGOON EFFLUENTS WAS FOUND TO BE A PROMISING AND ECONOMICALLY FEASIBLE MEANS OF UPGRADING WASTEWATER EFFLUENTS TO MEET MORE STRINGENT WATER QUALITY STANDARDS OF TODAY. WHILE THE PROCESS WAS FOUND TO BE VERY EFFICIENT AT OXIDIZING APPLIED NITROGEN COMPOUNDS, IT WAS ALSO FOUND TO BE INEFFICIENT AT REMOVING APPLIED PHOSPHORUS COMPOUNDS. THE PROCESS WAS FOUND TO BE CAPABLE OF REMOVING APPRECIABLE AMOUNTS OF APPLIED ALGAE, STILL SOME ALGAE WERE FOUND TO PASS THE ENTIRE FILTER DEPTH. WHEN OPERATING UNDER APPLIED BOD CONCENTRATIONS TYPICAL IN A PROPERLY OPERATED SECONDARY BIOLOGICAL TREATMENT PLANT EFFLUENT, THE PROCESS WAS FOUND TO CONSISTENTLY MEET PRESENT UTAH CLASS 'C' WATER QUALITY STANDARDS FOR BOD (EQUAL TO OR LESS THAN 5 MG/L). VERY HIGH TOTAL COLIFORM REMOVAL EFFICIENCY WAS EXHIBITED BY THE PROCESS OF INTERMITTENT SAND FILTRATION. THE NUMBER OF CONSECUTIVE DAYS OF OPERATION BEFORE CLEANING WAS REQUIRED WAS FOUND TO BE RELATED TO THE HYDRAULIC LOADING RATE AND THE FILTER INFLUENT SUSPENDED SOLIDS CONCENTRATION. IT WAS ESTIMATED THAT AN EFFLUENT POLISHING INTERMITTENT SAND FILTER PROCESS CAN BE CONSTRUCTED AND OPERATED AT A COST RANGING FROM $15 TO $47 PER MILLION GALLONS OF FILTRATE.

SEVERAL METHODS OF ALGAE REMOVAL IN MUNICIPAL OXIDATION PONDS.
MARTIN, DONALD M.
KANSAS UNIV., LAWRENCE.
MASTER'S THESIS, UNIVERSITY OF KANSAS, DECEMBER 1970. 82 P, 22 FIG, 6 TAB, 19 REF.
*SUSPENDED SOLIDS, SODIUM HYDROXIDE, *ROCK FILTERS.
05D
EFFLUENT FROM AN OXIDATION POND WAS COLLECTED AND USED BOTH FOR A JAR TEST AND FOR RUNS THROUGH AN UPFLOW ROCK FILTER. A WIDE VARIETY OF COAGULANTS AND THE NEW POLYELECTROLYTES WERE USED IN THE HOPE OF DISCOVERING SOME ECONOMICAL MEANS OF REMOVING ALGAE FROM OXIDATION POND EFFLUENTS. LIME, ALUM AND SODIUM HYDROXIDE WERE TESTED FOR USE AS FLOCCULENTS. WHILE CALGON'S CAT-FLOC WAS USED AT A CONCENTRATION OF 8 MG/L AS A FLOCCULENT AID. NO COST FIGURES WERE REPORTED, BUT THE ADDITION OF AN EXTENSIVE DOSING, MIXING, AND SEDIMENTATION SYSTEM, PLUS THE FACT THAT AS MUCH AS 120 MG/L OF FLOCCULENT WOULD BE REQUIRED, INDICATED THE PROCESS WOULD DEFEAT THE MAIN PURPOSE OF OXIDATION PONDS, NAMELY LOW COST AND LITTLE OR NO MAINTENANCE. THE ROCK FILTERS, HOWEVER, SHOWED MUCH MORE PROMISE. OPERATED ONLY BY THE HYDRAULIC HEAD OF THE POND LEVEL, THE FILTERS REQUIRED NO MECHANICAL, ELECTRICAL, OR CHEMICAL EQUIPMENT AND LITTLE OR NO MAINTENANCE. SINCE COD WAS SHOWN TO BE PRESENT BOTH IN DISSOLVED AND SUSPENDED FORMS, THEN THE DIFFERENCE BETWEEN SOLUBLE COD AND TOTAL COD WOULD INDICATE THE EFFICIENCY OF REMOVAL OF SUSPENDED MATTER IN THE ROCK FILTER. ON THIS BASIS, ROCK FILTERS WERE SHOWN TO BE CAPABLE OF REMOVING 80 TO 90% OF THE SUSPENDED MATERIAL COD. FURTHER FIELD SCALE TESTS WERE RECOMMENDED FOR THE ESTABLISHMENT OF OPERATIONAL PARAMETERS AND DESIGN CRITERIA. (LOWRY-TEXAS)

WATER RECLAMATION AND ALGAE HARVESTING.
MCGARRY, M. G.; TONGKASAME, C.
ASIAN INST. OF TECH., BANGKOK (THAILAND).
JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL. 43, NO 5, MAY 1971, P 824-836, 9 FIG, 3 TAB, 9 REF.
*ALGAE HARVESTING.
05D
APPLICATION OF HIGH RATE OXIDATION PONDS EQUIPPED WITH ALGAE HARVESTING MAY HELP TO AUGMENT THE DWINDLING WATER SUPPLIES OF LARGE METROPOLITAN AREAS BY RECLAIMING WASTE WATER FOR VARIED USES, WHILE AT THE SAME TIME PRODUCING A USABLE ALGAL FEED SUPPLEMENT. CONDITIONS FOR OPTIMAL OPERATION INCLUDE: (1) 200 LB BOD/ACRE/DAY; (2) 17.7 IN. DEPTH; AND (3) 1 DAY DETENTION TIME. PONDS OPERATED IN THIS MANNER

PROVIDE AN AVERAGE EFFLUENT BOD (AFTER ALGAE REMOVAL) OF LESS THAN 10 MG/L, AND ONE ACRE OF POND CAN PRODUCE 100,000 LB PER YER OF ALGAE CONTAINING 60% PROTEIN. CHEMICAL COAGULATION AND PRECIPITATION CHEMICALS STUDIED INCLUDED LIME, ALUM, AND 50 DIFFERENT POLYELECTROLYTES. POLYCATIONS WERE FOUND TO BE MOST ECONOMIC, BUT USAGE OF POLYELECTROLYTES AS AIDS CONTRIBUTED A GREATER CHEMICAL COST THAN USAGE OF ALUM ALONG AT PH 6.5. THE DOWNFLOW SOLIDS CONTACT SYSTEM WAS EXAMINED FOR REMOVAL OF THE ALGAE, EITHER BY THE SPLIT FLOW, DISSOLVED AIR, OR SUPERSATURATED OXYGEN PRINCIPLES. THE ALGAL PASTE WAS SUN DRIED ON UNDRAINED FLAT PLATES, TO LESS THAN 10% MOISTURE. AT SOLAR ENERGY LEVELS OF 480 G CAL/SQ CM/DAY, 2800 LBS/DAY OF DRIED ALGAE COULD BE PROCESSED ON ONE ACRE. THE RESULTS OF THE INVESTIGATIONS WERE INCORPORATED INTO AN URBAN MODEL WHICH INCLUDES RECYCLING OF CLARIFIED POND EFFLUENT FOR HOUSEHOLD CLEANING PURPOSES. A 67% REDUCTION IN RAW WATER NEEDS WAS PREDICTED FOR SUCH A SYSTEM, BUT MUCH FURTHER INVESTIGATION AND REFINEMENT IS NECESSARY. (LOWRY-TEXAS)

WASTEWATER RECLAMATION UNDER TROPICAL CONDITIONS.
MCGARRY, M. G.; NG, K. S.; LEUNG, N. H.; LEE, T. L.
ASIAN INST. OF TECH., BANGKOK, (THAILAND). DEPT. OF ENVIRONMENTAL ENGINEERING.
IN: WATER FOR THE HUMAN ENVIRONMENT, VOLUME III, TECHNICAL SESSIONS; PROCEEDINGS OF THE FIRST WORLD CONGRESS ON WATER RESOURCES (4 VOL), CHICAGO, ILLINOIS, SEPTEMBER 24-28, 1973. P 61-75. 4 FIG, 18 REF.
*THAILAND(BANGKOK), NITROGEN STRIPPING, ROUGHING FILTERS.
05D;C2A
THE DEVELOPMENT OF UNIT PROCESSES AND THEIR INTEGRATION FOR PURPOSES OF RECLAIMING DOMESTIC WASTEWATER FOR MUNICIPAL AND INDUSTRIAL REUSE WERE DESCRIBED. TWO INTEGRATED PROCESSES WERE UTILIZED, COMMON TO BOTH WERE TWO HIGH RATE OXIDATION PONDS FOLLOWED BY ROUGHING FILTERS THAT WERE EFFECTIVE IN REDUCING BOD LEVELS TO LESS THAN 20 MG/L AND IN REMOVING MUCH OF THE NITROGEN. THE CLARIFIED N-STRIPPED EFFLUENT OF THE SECOND ROUGHING FILTER NORMALLY EXHIBITED COD LEVELS ABOVE 30 MG/L. TWO ALTERNATIVE PROCESSES OF COD REMOVAL WERE INVESTIGATED. THE FIRST INVOLVED POWDERED ACTIVATED CARBON ADSORPTION, UPFLOW, SEDIMENTATION, AND DUAL MEDIA FILTRATION. THE SECOND CONSISTED OF SEMI-RAPID FILTRATION. THE AVERAGE LEVEL OF FINAL EFFLUENT TOTAL NITROGEN WAS 8.8 MG/L-N FOR THE CARBON ADSORPTION PROCESS AND 8.2 MG/L-N FOR THE SEMI-RAPID FILTRATION PROCESS. AVERAGE FINAL EFFLUENT COD LEVELS WERE 5.5 AND 11.0 MG/L RESPECTIVELY.

UPFLOW FILTRATION IMPROVES OXIDATION POND EFFLUENT.
MCGHEE, T. J.; PATTERSON, R. K.
NEBRASKA UNIV., LINCOLN. ENGINEERING RESEARCH CENTER.
WATER AND SEWAGE WORKS, VOL 121, NO 7, P 82-83, JULY 1974. 3 FIG, 11 REF.
*UPFLOW FILTRATION.
05D
OXIDATION PONDS ARE AN EFFECTIVE, UNCOMPLICATED AND ECONOMICAL WAY OF TREATING DOMESTIC SEWAGE AND CERTAIN INDUSTRIAL WASTES. THE SYSTEM REQUIRES NO SKILLED OPERATOR OR MAINTENANCE. THROUGH EVAPORATION AND SEEPAGE THE TOTAL REDUCTION IN BOD THROUGH AN OXIDATION POND CAN APPROACH 95 PERCENT. ALTHOUGH THE ACTUAL CONCENTRATION OF BOD AND SUSPENDED SOLIDS MAY NOT MEET THE NEW STANDARDS OF 30 MG/LITER MONTHLY AVERAGE AND 45 MG/LITER WEEKLY AVERAGE DETERMINED FOR SECONDARY TREATMENT. THE MATERIAL WHICH CONTRIBUTES TO THE BOD EFFLUENT AND SUSPENDED SOLIDS OF OXIDATION PONDS IS LARGELY ALGAL CELLS UTILIZING INORGANIC BYPRODUCTS OF THE BACTERIAL OXIDATION OF THE WASTE. TECHNIQUES LISTED FOR REMOVAL OF ALGAE INCLUDE COAGULATION WITH ALUM, COAGULATION WITH ALUM AND POLYELECTROLYTES, FLOCCULATION AND AGGREGATION ON CATIONIC EXCHANGE RESINS, CHLORINE DISINFECTION, ANAEROBIC ROCK FILTERS, FLY ASH SLURRY FILTRATION, PRESSURE FILTRATION THROUGH A DIATOMACEOUS EARTH FILTER, AND SAND FILTRATION.

UPFLOW FILTRATION OF OXIDATION POND EFFLUENT.
MCGHEE, T. J.
NEBRASKA UNIV., LINCOLN. DEPT. OF CIVIL ENGINEERING.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-243 529, $3.25 IN PAPER COPY, $2.25 IN MICROFICHE. COMPLETION REPORT, JUNE 1975. 12 P, 6 TAB, 3 REF. OWRT A-034-NEB(1), 14-31-0001-5027.
*UPFLOW FILTRATION SYSTEMS.
05D
AN UPFLOW FILTRATION SYSTEM EMPLOYING A SAND MEDIUM WAS CONSTRUCTED AND OPERATED AT THE MUNICIPAL OXIDATION PONDS IN LINCOLN, NEBRASKA. THE SYSTEM WAS OPERATED AT LOADING RATES OF 0.5 TO 3.0 GAL/FT SQ/MIN (6.25 TO 37.5 GAL/MIN) AND BACKWASHED AT A RATE OF APPROXIMATELY 15 GAL/FT SQ/MIN (190 GAL/MIN). FLOW WAS PROVIDED BY ELECTRICALLY DRIVEN CENTRIFUGAL PUMPS. ROUTINE DATA MEASURES INCLUDED COD AND

SUSPENDED SOLIDS OF INFLUENT AND EFFLUENT AND BOD OF INFLUENT AND EFFLUENT WHEN THE SOLIDS CONCENTRATION IN THE EFFLUENT MET CURRENT DISCHARGE STANDARDS (30 MG/L). MODIFICATIONS TO THE SYSTEM MADE DURING THE STUDY INCLUDED THE ADDITION OF A STEEL GRID TO RESTRAIN THE FILTER MEDIUM AGAINST PREMATURE EXPANSION AND SUBSTITUTION OF A COARSER SAND (.5MM) FOR THAT ORIGINALLY USED (.22MM). CONCLUSIONS WERE: (1) THE SUSPENDED SOLIDS AND BOD OF OXIDATION POND EFFLUENT MAY BE REDUCED BY FILTRATION THROUGH A SAND MEDIUM; AND (2) EFFICIENCY OF REMOVAL DECREASES SHARPLY WITH INCREASED FILTRATION RATE.

CHARACTERIZATION OF DISPERSED RESIDUAL SOLIDS IN BIOLOGICALLY TREATED PULP AND PAPER MILL EFFLUENTS
MCKEOWN, J. J.; COSTA, H. S.
NATIONAL COUNCIL OF THE PAPER INDUSTRY FOR AIR AND STREAM IMPROVEMENT, INC., NEW YORK.
NCASI STREAM IMPROVEMENT TECHNICAL BULLETIN, NO 303, 24 P, FEBRUARY, 1978. 4 FIG, 10 ILLUS, 5 REF, 4 TAB.
FIELD 05D, 05A
THE PARTICLE SIZE AND SIZE DISTRIBUTION OF SUSPENDED SOLIDS IN BIOLOGICALLY TREATED EFFLUENTS FROM THREE FULL-SCALE AERATED STABILIZATION BASINS AND A PILOT-PLANT BASIN WERE DETERMINED USING SCANNING ELECTRON AND OPTICAL MICROSCOPY. THE SOLIDS WERE ALSO CHARACTERIZED BY ZETA-POTENTIAL MEASUREMENTS AND BY DETERMINATION OF THEIR DEOXYRIBONUCLEIC ACID CONTENT. THE STUDY SHOWED THAT THE RESIDUAL SOLIDS WERE PRINCIPALLY ORGANIC IN NATURE AND GENERATED DURING TREATMENT. PARTICLE SIZES WERE 1-8 MICROMETERS, A SUITABLE RANGE FOR AQUATIC INSECT FOOD AND A LIMITING RANGE FOR EFFECTIVE REMOVAL BY SEDIMENTATION AND FILTRATION. THE STABILITY OF THESE DISPERSED SOLIDS IS ATTRIBUTED TO STERIC HINDRANCE AND/OR ADSORPTION OF HYDRATED HYDROPHILIC COLLOIDS RATHER THAN TO CHARGE REPULSION. (SWICHTENBERG-IPC)

CHARACTERIZING EFFLUENT VARIABILITY FROM PAPER INDUSTRY WASTEWATER TREATMENT PROCESSES EMPLOYING BIOLOGICAL OXIDATION.
MCKEOWN, J. J.; CELLMAN, I.
TUFTS UNIV., MEDFORD, MA.
PROGRESS IN WATER TECHNOLOGY, VOL 8, NO 1, P 147-163, 1976. 12 FIG, 1 REF, 6 TAB.
GROUNDWOOD MILLS, SULFITE PULP MILLS, KRAFT MILLS, DEINKING MILLS, *BIOLOGICAL OXIDATION.
05D;05A;05D
THE VARIABILITY EXISTING IN FINAL EFFLUENTS DISCHARGED FROM THE PULP AND PAPER INDUSTRY IS REVIEWED FOR SEVERAL INTEGRATED MILLS WITH DIFFERENT PULPING OPERATIONS, INCLUDING GROUNDWOOD, SULFITE, BLEACHED KRAFT, AND WASTE PAPER DEINKING MILLS. EFFLUENT TREATMENT SYSTEMS ASSOCIATED WITH THESE MANUFACTURING OPERATIONS INCLUDE ACTIVATED SLUDGE, AERATION STABILIZATION SYSTEMS (SINGLE- AND TWO-STAGE) WITH POST-STORAGE FOLLOWING SEVERAL OF THE BIOLOGICAL OXIDATION SYSTEMS. SUSPENDED SOLIDS AND BOD (LB/DAY) ARE EXAMINED FOR FREQUENCY DISTRIBUTION, COEFFICIENT OF VARIATION, AUTOCORRELATION, AND POWER SPECTRUM. WITH FEW EXCEPTIONS, EFFLUENT BOD AND SUSPENDED SOLIDS FREQUENCIES ARE MORE CENTRALLY DISTRIBUTED USING THE LOGARITHM OF THE DATA. VARIATIONS IN THE ANNUAL AVERAGES OF BOD AND SUSPENDED SOLIDS SHOW WIDE RANGES, INDICATING MAJOR DIFFERENCES IN THE MANUFACTURING PROCESS AND/OR TREATMENT SYSTEMS. INSIGHT INTO THE TRENDS AND FREQUENCIES WHICH EXIST IN THE EFFLUENT DATA WAS OBTAINED FROM A TIME SERIES ANALYSIS. (SWICHTENBERG-IPC)

OVERLOADED OXIDATION PONDS--TWO CASE STUDIES.
MCKINNEY, ROSS E.
KANSAS UNIV., LAWRENCE. DEPT. OF CIVIL ENGINEERING.
JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 40, NO 1, P 49-56, JAN 1968. 9 TAB, 7 REF.
*AERATION TUBES, *DIFFUSERS, *RAYTOWN(MO), LEE'S SUMMIT(MO), OXYGEN TRANSFER, PH, SUSPENDED SOLIDS.
05D;05G
THE USE OF A DIFFUSED AERATION SYSTEM AS A MEANS OF INCREASING THE CAPACITY AND IMPROVING THE PERFORMANCE OF OVERLOADED OXIDATION PONDS WAS EVALUATED IN A ONE YEAR DUAL STUDY OF THE PONDS AT LEE'S SUMMIT AND RAYTOWN, MO. THE SUPPLEMENTAL AERATION SYSTEM CONSISTED OF POLYETHYLENE TUBE DIFFUSERS, A COMMON HEADER, AND AN AIR COMPRESSOR. DATA ACCUMULATED DURING THE TEST PERIOD INCLUDE BOD, COD, SUSPENDED SOLIDS, PH, AND DISSOLVED OXYGEN. BIOCHEMICAL OXYGEN DEMAND (BOD) AND COD REMOVAL AVERAGED 80% AND 54% AT LEE'S SUMMIT, RESPECTIVELY. THE POND COVERED 25 ACRES, WITH AN AVERAGE DEPTH OF 5 FEET AND AN AVERAGE DETENTION PERIOD OF 30 DAYS. THE BOD5 LOAD TO THE POND WAS ESTIMATED TO BE 2550 LBS/DAY. THE OXIDATION POND AT RAYTOWN CONSISTED OF A FIRST-STAGE AERATED LAGOON WITH TWO 15-HP AERATORS FOLLOWED BY A SECOND-STAGE LAGOON, WHERE THE PLASTIC AERATION TUBING WAS INSTALLED. ESTIMATED TO RECEIVE AN ORGANIC LOAD OF 1000 LBS BOD5/DAY. ORGANIC REMOVAL EFFICIENCIES WERE SIMILAR TO THE LEE'S SUMMIT SYSTEM AS A STATISTICAL BASIS. THE PLASTIC TUBING AERATION UNITS CAN PRODUCE AN EFFLUENT UNDER

30 MG/L BOD5 AT A LOADING OF 1000 PEOPLE/D/AC. BUT, THE STUDY INDICATES THAT THE AERATION TUBING SHOULD BE USED WITH CAUTION. IT CAN ASSIST OVERLOADED OXIDATION PONDS BY IMPROVING MIXING, BUT IS NOT A CURE-ALL. CLOGGING OF THE AERATION TUBING WAS A PROBLEM RELIEVED BY TREATMENT WITH HYDROCHLORIC ACID, AND THE BASIC MECHANISM OF TREATMENT WAS INCREASED ALGAL METABOLISM THROUGH BETTER MIXING RATHER THAN DIRECT OXYGEN TRANSFER. (AGUIRRE-TEXAS)

STATE OF THE ART-AERATED LAGOONS.
MCKINNEY, ROSS E.
KANSAS UNIV., LAWRENCE. DEPT. OF CIVIL ENGINEERING.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 376-381, 42 REF.
*AERATED LAGOONS, MECHANICAL AERATORS, DIFFUSED AIR, DETENTION TIME, SUSPENDED SOLIDS.
05D
AERATED LAGOONS BECAME WIDELY ACCEPTED AS A FORM OF WASTE WATER TREATMENT IN THE 1960'S. THEIR MAIN APPLICATION SO FAR HAS BEEN IN THE AREA OF INDUSTRIAL WASTE TREATMENT. AERATED LAGOONS HAVE SUCCESSFULLY TREATED TEXTILE WASTES, PAPER WASTES, SLAUGHTERHOUSE WASTES, VARIOUS FOOD WASTES, AND MANY OTHERS. BECAUSE THEY DO NOT DEPEND UPON ALGAE FOR OXYGEN, AERATED LAGOONS ARE MORE CONTROLLABLE BY THE OPERATOR. AERATION DEVICES HAVE BEEN DEVELOPED TO SUPPLY THESE BASINS BOTH WITH MIXING CAPACITY AND OXYGENATION CAPACITY. THE TWO BASIC TYPES IN USE ARE MECHANICAL SURFACE AERATORS, AND DIFFUSED AIR DEVICES, EACH HAVING ITS OWN MERIT. AERATED LAGOONS HAVE TAKEN A PLACE AS AN ESTABLISHED WASTE WATER TREATMENT TOOL. MUCH WORK REMAINS TO BE DONE REGARDING THE ACTUAL MIXING AND OXYGENATION REQUIREMENTS, TRUE LOADINGS, OPTIMUM DEPTH, ETC. THIS TYPE OF TREATMENT IS A COMBINATION OF BOTH ACTIVATED SLUDGE AND OXIDATION PONDS, AND IT FOLLOWS PREDICTABLY THE FUNDAMENTAL KINETICS DERIVED FOR THESE TWO PROCESSES. WHEN CAREFULLY DESIGNED, CONSTRUCTED, AND MAINTAINED, IT CAN PROVIDE ECONOMICAL EFFICIENT WASTE TREATMENT FOR A WIDE VARIETY OF WASTES. (SEE ALSO W71-07079) (LOWRY-TEXAS)

KINETICS OF ALGAL SYSTEMS IN WASTE TREATMENT FIELD STUDIES.
MERON, AARON; OSWALD, WILLIAM J.; GEE, HENRY
CALIFORNIA UNIV., BERKELEY. SANITARY ENGINEERING RESEARCH LAB.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE AS PB-206 812, $6.00 IN PAPER COPY, $0.95 IN MICROFICHE. FINAL REPORT PART III, MAY 1971, 334 P, 46 FIG, 44 TAB, 122 REF. FWQA PROGRAM 17010 DZO 05/71.
*ALGAL GROWTH RATES.
05D
THREE DOMESTIC SEWAGE STABILIZATION POND SYSTEMS WERE STUDIED TO EVALUTE THE RELATIONSHIP BETWEEN DESIGN CRITERIA AND PERFORMANCE CRITERIA FOR POND SYSTEMS IN ACCOMPLISHING SPECIFIC WASTE TREATMENT STEPS. SYSTEM 1 CONSISTED OF A LINED HIGH-RATE POND FOLLOWING SEDIMENTATION, SYSTEM 2 WAS COMPRISED OF CONVENTIONAL SECONDARY WASTE TREATMENT FOLLOWED BY A POND SYSTEM, AND SYSTEM 3 CONSISTED SOLELY OF SEVERAL DEEP PONDS IN SERIES. STUDY RESULTS INDICATED THAT SYSTEM 3, CONSISTING OF AN ANEROBIC POND, AND UNLINED HIGH-RATE POND, AND DEEP HIGH-RATE POLISHING POND, WAS EFFECTIVE IN BOTH BOD AND NUTRIENT REMOVALS, WITH MEAN ANNUAL REMOVALS OF 97.3%, 93.2%, 91.6%, AND 64.5% FOR BOD, COD, TOTAL NITROGEN, AND PHOSPHATE. RESULTS CONFIRMED THAT POND FUNCTIONING IS DETERMINED BY POSITION WITH RESPECT TO OTHER PONDS AND UNIT PROCESSES, AS WELL AS THEIR INDIVIDUAL DESIGN CHARACTERISTICS. OTHER STUDY RESULTS DEMONSTRATED THAT: (1) EFFICIENT N AND P REMOVAL DEPENDS UPON CARBON AVAILABILITY; (2) HIGH-RATE PONDS DEVELOP A SLUDGE-SLIME BOTTOM LAYER WHICH PREVENTS EROSION; (3) PROPER NUTRIENT BALANCE, AS MEASURED BY C:N AND C:P IS ESSENTIAL FOR EFFECTIVE ALGAL GROWTH AND NUTRIENT REMOVAL; (4) DEEP ANAEROBIC PONDS SHOULD BE OPERATED AS AN AEROBIC LAYER ABOVE AN ANAEROBIC LAYER; AND (5) NUTRIENT BALANCE AS WELL AS PH CAN BE ADJUSTED IN HIGH RATE PONDS BY CO2 ADDITION. (LOWRY-TEXAS)

STABILIZATION POND UPGRADING WITH INTERMITTENT SAND FILTERS.
MIDDLEBROOKS, E. J.; MARSHALL, G. R.
UTAH STATE UNIV., LOGAN. COLL. OF ENGINEERING.
IN: UPGRADING WASTEWATER STABILIZATION PONDS TO MEET NEW DISCHARGE STANDARDS, AUGUST 21-23, 1974, LOGAN, UTAH. UTAH STATE UNIVERSITY, P 47-69, 8 FIG, 19 TAB, 13 REF.
*INTERMITTENT SAND FILTERS, HYDRAULIC LOADING RATES, ALGAE REMOVAL.
05D
INTERMITTENT SAND FILTRATION CAN BE USED IN COMMUNITIES SURROUNDED BY LARGE AREAS OF OPEN LAND. THE PERFORMANCE OF THE FILTERS ON A LABORATORY AND PILOT FIELD SCALE WAS EVALUATED. NINE LABORATORY SCALE FILTERS AND NINE FIELD FILTERS WERE EVALUATED. SANDS USED HAD EFFECTIVE SIZES OF 0.17, 0.35, AND 0.72

MM. HYDRAULIC LOADING RATES OF 100,000 GPAD, 200,000 GPAD, AND 300,000 GPAD WERE USED. SUSPENDED SOLIDS, PH, AND TEMPERATURE WERE MEASURED ONCE EVERY DAY, AND SAMPLES WERE ANALYZED ONCE A WEEK FOR BIOCHEMICAL OXYGEN DEMAND, AMMONIA, NITRATE, NITRITE, ORTHOPHOSPHATE, PHOSPHORUS, SUSPENDED SOLIDS AND PH. HYDRAULIC LOADING RATE HAD LITTLE TO DO WITH ANY OF THE PARAMETERS IN THE LABORATORY TESTS, BUT IN THE FIELD TESTS INCREASED HYDRAULIC LOADING CAUSED A DECREASE IN THE SUSPENDED SOLIDS REMOVAL. SMALLER SIZE SANDS OXIDIZED NITROGEN COMPOUNDS BETTER. IN THE LABORATORY, HYDRAULIC LOADING RATES HAD LITTLE EFFECT ON THE ABILITY OF SAND TO OXIDIZE NITROGEN. AMMONIA PRIMARILY PROVIDED THE NITROGEN WHICH WAS OXIDIZED. AFTER EQUILIBRIUM WAS ESTABLISHED, THE INTERMITTENT SAND FILTERS DID NOT REMOVE A SIGNIFICANT QUANTITY OF DISSOLVED PHOSPHORUS COMPOUNDS. BOD REMOVAL INCREASED AS THE EFFECTIVE SAND SIZE DECREASED, AS DID ALGAL AND SUSPENDED AND VOLATILE SOLIDS REMOVALS. SOME ALGAE CELLS PASSED THROUGH THE ENTIRE SAND COLUMN WITHOUT BEING REMOVED. ALL WASTE WATER TREATMENT PLANTS CAN BE UPGRADED BY INTERMITTENT SAND FILTRATION TO MEET CLASS 'C' STANDARDS IN THE STATE OF UTAH. THE PROCESS CAN BE CONSTRUCTED AND OPERATED AT A COST RANGING BETWEEN 15 AND 47 DOLLARS PER MILLION GALLONS OF FILTRATE.

CHALLENGE FOR WASTE WATER LAGOONS.
MIDDLETOWN, FRANCIS M.; BUNCH, ROBERT L.
FEDERAL WATER QUALITY ADMINISTRATION, CINCINNATI, OHIO. ADVANCED WASTE TREATMENT RESEARCH LAB.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI. P 364-366.
SUSPENDED SOLIDS.
05D
INCREASING USE OF WATER HAS NECESSITATED GREATER AND GREATER USAGE OF RECONDITIONED WASTE WATER AS DRINKING WATER. WITH THIS GREATER USAGE HAS COME INCREASINGLY STRICTER LAWS REGARDING THE QUALITY OF THE EFFLUENT WHICH A TREATMENT FACILITY IS PERMITTED TO DISCHARGE TO A RECEIVING WATER. THEREFORE TREATMENT METHODS MUST BECOME MORE SOPHISTICATED AS TIME GOES ON IN ORDER THAT EFFLUENTS NOT ONLY PRESERVE THE QUALITY OF A RECEIVING STREAM, BUT MUST HELP TO RESTORE IT. IN LIGHT OF THESE FACTS LAGOON PERFORMANCE MUST BE EVALUATED WITH RESPECT TO FUTURE CONDITIONS. LAGOONS HAVE SEVERAL DRAW BACKS FROM A WATER POLLUTION STANDPOINT. THESE ARE: (1) ALTHOUGH COLIFORMS MAY BE REDUCED AS MUCH AS 98% IN A LAGOON, THE WATER QUALITY STANDARDS FOR NUMBER OF ORGANISMS PER MILLILITER MAY STILL BE VIOLATED; (2) IF ALGAE IS ALLOWED TO PASS TO THE RECEIVING STREAM, IT MAY BECOME AS MUCH OF A POLLUTIONAL FACTOR AS THE RAW WASTE SINCE IT CONTAINS THE SAME AMOUNT OF ORGANIC MATTER; (3) LAGOON EFFLUENT IS HIGH IN SUSPENDED SOLIDS WHICH ARE BOTH AESTHETICALLY UNPLEASING AND OXYGEN DEMANDING; (4) LAGOONS ARE A THREAT TO GROUNDWATER QUALITY BECAUSE OF THE DIFFICULTY IN SEALING THEM. UNTIL NOW, THE MOST ATTRACTIVE FEATURE OF LAGOONS HAS BEEN THEIR LOW COST. AS TREATMENT MUST BECOME MORE SOPHISTICATED, LAGOONS AS PRESENTLY CONSTRUCTED WILL NEED ADDITIONAL TREATMENT WHICH WILL MORE THAN OFFSET THEIR COST ADVANTAGE. THEREFORE, UNLESS SIGNIFICANT ADVANCES ARE MADE IN LAGOON TECHNOLOGY, IT IS DOUBTFUL IF LAGOONS WILL HAVE A PLACE IN THE FUTURE.

WASTE TREATMENT LAGOONS-STATE OF THE ART.
MISSOURI BASIN ENGINEERING HEALTH COUNCIL, CHEYENNE, WYO.
COPY AVAILABLE FROM GPO SUP DOC, $1.25; MICROFICHE FROM NTIS AS PB-209 937, $0.95. ENVIRONMENTAL PROTECTION AGENCY WATER POLLUTION CONTROL RESEARCH SERIES, JULY 1971. 152 P, 9 TAB, 42 REF. EPA PROGRAM 17050 EHX 07/71.
*FACULTATIVE LAGOONS, *ANAEROBIC LAGOONS.
05D;16F
A REVIEW OF PUBLISHED LITERATURE AND FIELD EVALUATIONS REVEALED THE PRESENCE OF OVER 3500 WASTE TREATMENT LAGOONS CURRENTLY IN OPERATION IN THE UNITED STATES. THE THREE TYPES OF LAGOONS IN USE INCLUDE: (1) OXIDATION LAGOONS; (2) AERATED LAGOONS, AND (3) ANAEROBIC LAGOONS. OXIDATION LAGOONS DEPEND UPON ALGAE TO SUPPLY OXYGEN BY PHOTOSYNTHESIS AND DEGRADE THE WASTE PRODUCTS. EFFLUENT QUALITY IS DETERMINED BY THE QUANTITY OF ALGAE IN THE EFFLUENT AND SEVERAL METHODS OF ALGAE REMOVAL ARE CURRENTLY UNDER INVESTIGATION. AERATED LAGOONS MAY BE MERELY OXIDATION PONDS WITH SUPPLEMENTAL AERATION, PARTIALLY MIXED ACTIVATED SLUDGE (FACULTATIVE AERATED) OR COMPLETE MIX ACTIVATED SLUDGE (CMAS) SYSTEMS. HIGH QUALITY EFFLUENTS FROM AERATED LAGOONS CAN BE ACHIEVED ONLY BE REMOVING EFFLUENT MICROBIAL SOLIDS. ANAEROBIC LAGOONS CAN PROVIDE UP TO 80% BOD REMOVALS, BUT MUST BE FOLLOWED BY SOME TYPE OF AEROBIC TREATMENT TO PRODUCE A HIGH QUALITY EFFLUENT. THIS REVIEW HAS DEMONSTRATED THAT LAGOONS DO HAVE APPLICABILITY TO THE TOTAL WASTE TREATMENT PROBLEM, BUT THE FUTURE OF LAGOONS DEPENDS UPON PROPER DESIGN AND OPERATION IN RELATIONSHIP WITH THE FUNDAMENTAL BIOCHEMISTRY OF THE MICROBES IN THE VARIOUS SYSTEMS. (KCWRY-TEXAS)

EFFECT OF INDUSTRIAL WASTES ON OXIDATION POND PERFORMANCE.
MOSHE, M.; BETZER, N.; KOTT, Y.
WATER RESEARCH, VOL 6, NO 10, P 1165-1171, OCTOBER 1972. 1 FIG, 4 TAB, 12 REF.
CHLORELLA SOROKINIANA, POLLUTANT EFFECTS, MOST PROBABLE NUMBER TEST, ALGAL COUNTS.
05C;05D
CADMIUM, COPPER, NICKEL, ZINC, AND HEXAVALENT CHROMIUM IONS WERE TESTED IN A BENCH-BIOASSAY EXPERIMENT FOR TOXICITY LIMITS AND POSSIBLE APPLICATION TO EXPERIMENTAL OXIDATION PONDS. DOMESTIC SEWAGE WAS PLACED INTO TEST TUBES WHERE PREDETERMINED CONCENTRATIONS OF METAL IONS WERE ADDED TOGETHER WITH KNOWN INITIAL CONCENTRATIONS OF CHLORELLA SOROKINIANA. THE TEST TUBES WERE INCUBATED UNDER CONTROLLED ILLUMINATION (1500 IX) AT 29 C. BEFORE AND AFTER INCUBATION COLIFORM COUNTS (MPN) WERE CARRIED OUT ACCORDING TO STANDARD METHODS (1965). ALGAL COUNTS WERE PERFORMED USING A HAEMOCYTOMETER. EXPERIMENTAL PONDS OF 50-70 L VOLUME WERE FED WITH DILUTED DOMESTIC SEWAGE (BOD EQUAL 200 MG/L). PREDETERMINED QUANTITIES OF METAL SALTS HAD BEEN PREVIOUSLY ADDED TO GIVE THE DESIRED CONCENTRATION OF METAL IONS IN THE INFLOWING SEWAGE. AT THE FINAL STAGE OF THE STUDY, AN AQUARIUM OF 80 L CAPACITY WAS OPERATED AS EXPERIMENTAL POND. TO THIS POND A MIXTURE OF METAL IONS (CR, CD, CU, NI, AND ZN) WAS INTRODUCED, BEGINNING WITH 3 MG/L AND INCREASING TO 12 MG/L OF EACH ION. SAMPLES TAKEN FROM THE PONDS WERE SUBJECTED TO THE FOLLOWING TESTS: PH, DISSOLVED OXYGEN, BOD, MPN, ALGAL COUNT AND DETERMINATION OF METAL ION CONCENTRATION. THE SAMPLES WERE TAKEN FROM THE INFLUENT, EFFLUENT AND BOTTOM SLUDGE. IT WAS FOUND THAT THE METAL IONS ARE TOXIC, INHIBITING CHLORELLA GROWTH. HOWEVER, WHEN ADDED AT CONCENTRATIONS OF 0.5-1.5 MG/L TO INFLUENT OF OXIDATION PONDS, THE PONDS CONTINUED TO OPERATE NORMALLY. HIGHER CONCENTRATIONS OF 3 AND 6 MG/L DID NOT EFFECT ADVERSELY POND PERFORMANCE - NOT EVEN A CONCENTRATION OF 6 MG/L OF EACH ION (A TOTAL METAL ION CONCENTRATION OF 30 MG/L). A MIXTURE OF 60 MG/L METAL IONS BROUGHT ABOUT A DECREASE IN ALGAL NUMBERS AND CAUSED A SHARP DROP IN DISSOLVED OXYGEN CONCENTRATION. IT IS BELIEVED THAT SINCE HIGH PH CAUSES METAL IONS TO PRECIPITATE, OXIDATION PONDS OPERATING NORMALLY ABOVE PH 8.0 WILL TOLERATE METAL IONS IN SEWAGE CONTAINING INDSTRIAL WASTES FOR A LONG TIME BEFORE SLUDGE ACCUMULATION WILL AFFECT POND PERFORMANCE. (HOLOMAN-BATTELLE)

HARVEST OF BIOLOGICAL PRODUCTION AS A MEANS OF IMPROVING EFFLUENTS FORM SEWAGE LAGOONS.
NEIL, J. H.
CANADA-ONTARIO AGREEMENT ON THE GREAT LAKES WATER QUALITY, RESEARCH REPORT NO. 38, TRAINING AND TECHNOLOGY TRANSFER DIVISION (WATER), ENVIRONMENTAL PROTECTION SERVICE, ENVIRONMENT CANADA, OTTAWA, CANADA, 1976. 35 P, 38 REF, 9 TAB.
DUCKWEED, *BIOLOGICAL HARVESTING, RAW SEWAGE.
THE FEASIBILITY OF REMOVING PHOSPHORUS, NITROGEN AND ORGANIC MATTER THROUGH THE HARVESTING OF ALGAE, DUCKWEEK (LEMNA SP.), DAPHNIA (CLADOCERA) OR MIDGE LARVAE (TENDIPEDIDAE) HAS BEEN EXAMINED USING ANALYTICAL INFORMATION FROM FIVE ONTARIO SEWAGE LAGOONS AND INFORMATION ON PRODUCTION AND CHEMICAL COMPOSITION OF THE BIOTA DERIVED FROM THE LITERATURE. EFFLUENT ANALYSES SHOWED THAT AN AVERAGE OF 1.7 PPM MORE TOTAL PHOSPHORUS MUST BE REMOVED TO MEET A 1 PPM TOTAL PHOSPHORUS STANDARD FOR EFFLUENTS. HARVESTING PART OF THE ALGAE OR DUCKWEED CROP COULD PROVIDE THIS REDUCTION. PRODUCTION FIGURES FROM THE LITERATURE INDICATE DAPHNIA CULTURE WOULD PROVIDE THE NECESSARY REMOVAL FROM TWO TO FIVE LAGOONS. ONE INSTANCE WHERE MIDGE LARVAE PRODUCTION FOR AN ONTARIO LAGOON COULD BE CALCULATED INDICATED THAT A THREE-FOLD INCREASE IN STANDING CROP WOULD BE REQUIRED. DAPHNIA AND MIDGE LARVAE WOULD PROVIDE IMMEDIATELY USEFUL PRODUCTS FOR FISH CULTURE, THE VALUE OF WHICH COULD BE USED TO OFFSET PART OF HARVESTING AND SEWAGE TREATMENT COSTS. POSSIBLE MEANS OF INCREASING PRODUCTION AND HARVESTING METHODS ARE DISCUSSED. THE CULTURE AND HARVEST OF AQUATIC ORGANISMS PROVIDE ADDITIONAL BENEFITS THROUGH THE REMOVAL OF NITROGEN AND OTHER SEWAGE CONSTITUENTS, AND THEIR CULTURE IS PROPOSED AS A POSSIBLE ALTERNATIVE TO THE CHEMICAL PRECIPITATION PRACTICES CURRENTLY IN USE. (ENVIRONMENT CANADA)

BAFFLED BIOLOGICAL BASIS FOR TREATING POULTRY PLANT WASTES,
NEMEROW, NELSON L.
SYRACUSE UNIV., N.Y.
JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 41, NO 9, P 1602-1612, SEPTEMBER 1969. 8 FIG, 9 TAB.
*CHICKENS, FOOD WASTES, POULTRY WASTES,
05D
A POULTRY PLANT IN MILLSBOROUGH, DELAWARE, PROCESSED 10,000 CHICKENS PER HOUR WITH A WASTE WATER OF 40,000 GPH, AND AN EFFLUENT OF 2,500 LB BOD5/DAY AT AN AVERAGE BOD OF 630 MG/L. BECAUSE THE AREA IS COMMERCIALLY AND RECREATIONALLY OF GREAT VALUE A PROGRAM WAS INITIATED TO REDUCE THE WASTE WATER CONCENTRATION AT A MAXIMUM COST OF $100,000. ADEQUATE SCREENING FOLLOWED BY A TWO-STAGE OXIDATION POND PLANT UTILIZING OVER AND UNDER CONTACT BAFFLES IN THE FIRST STAGE FOLLOWED BY CHLORINATION PROVIDED A 85 TO 95% BOD REDUCTIONS. THE FIRST STAGE CONSISTS OF A BAFFLED HIGH-RATE DEEP POND. THE SECOND STATE

IS A SHALLOW SYNTHETIC BASIN. LOADINGS OF OVER 200 LB/DAY/ACRE RESULTED IN HIGH EFFICIENCY AND COLIFORM COUNTS OF LESS THAN 10/1000 ML. THE FINAL COST WAS $90,000. (HANCUFF-TEXAS)

OPERATION OF AN ANAEROBIC POND ON HOG ABATTOIR WASTEWATER.
NILES, C. F.; GORDON, H. P.
STEEG (HENRY D.) AND ASSOCIATES, INC., INDIANAPOLIS, IND.; AND WASTEWATER TREATMENT PLANT, LOGANSPOR
IN: PROCEEDINGS, INDUSTRIAL WASTE CONFERENCE, 25TH, MAY 5-7, 1970. PURDUE UNIVERSITY, ENGINEERING
EXTENSION SERIES NO. 137, PART II, P 612-616, 1 TAB.
*ABATTOIR WASTEWATER, ANAEROBIC LAGOONS, SECONDARY TREATMENT, SUSPENDED SOLIDS.
05D
THE DEVELOPMENT OF A DESIGN FOR AN ANAEROBIC POND FOR PRETREATMENT OF THE WASTEWATER FROM AN ABATTOIR, DESIGN CRITERIA AND DETAILS OF THE ANAEROBIC POND, AND THE OPERATING TECHNIQUES BEING USED IN TREATING THE EFFLUENT FROM THE ANAEROBIC POND BEFORE DISCHARGE TO THE RIVER ARE DESCRIBED. SOME INFORMATION ON OPERATING RESULTS, LABOR REQUIREMENTS AND POWER CONSUMPTION ARE ALSO INCLUDED. IT WAS ESTIMATED THAT PROCESSING 400 HOGS PER HOUR ON A ONE SHIFT KILL WOULD RESULT IN A FLOW OF 800,000 GAL PER DAY WITH A PEAK RATE OF 1400 GAL PER MIN. IT WAS FURTHER ESTIMATED THAT THIS WASTEWATER WOULD CONTAIN 8000 POUNDS OF BOD AND 6650 POUNDS OF SUSPENDED SOLIDS PER DAY. THE EFFLUENT FROM THE LAGOON WAS INTRODUCED INTO THE ACTIVATED SLUDGE SECONDARY TREATMENT STEP OF THE CITY SEWAGE TREATMENT PLANT. FOR SUCCESSFUL OPERATION ON A YEAR-ROUND BASIS, A COVER FOR THE LAGOON WAS CONSIDERED NECESSARY. THE COVER WAS COMPOSED OF STRAW AND GREASE AND MAINTAINED TEMPERATURES YEAR-ROUND ABOVE 80 DEGREES F. (DORLAND-IOWA

POLISHING LAGOON EFFLUENTS WITH SUBMERGED ROCK FILTERS.
O'BRIEN, R. J.
KANSAS UNIV., LAWRENCE. DEPT. OF CIVIL ENGINEERING.
IN: UPGRADING WASTEWATER STABILIZATION PONDS TO MEET NEW DISCHARGE STANDARDS, AUGUST 21-23, 1974. LOGAN, UTAH, UTAH STATE UNIVERSITY, P 31-46, 6 FIG, 12 TAB, 21 REF.
*SUBMERGED ROCK FILTERS, ALGAE REMOVAL, FILTER LIFE, TOTAL SUSPENDED SOLIDS, VOLATILE SUSPENDED SOLIDS.
05D
LAGOONS HAVE BEEN WIDELY USED IN SMALL COMMUNITIES AND ISOLATED INDUSTRIAL PLANTS IN THE UNITED STATES FOR MANY YEARS. REMOVAL OF ALGAE FROM THE FINAL EFFLUENT CAN BE COSTLY IF DONE BY STANDARD TECHNIQUES. SUBMERGED ROCK FILTERS, WHICH HAVE THE POTENTIAL FOR AVOIDING THIS COST, HAVE BEEN TESTED IN LABORATORY SCALE AND PILOT SCALE UNITS. FIELD SCALE TRIALS ARE REPORTED IN THIS PAPER. TWO FILTERS WERE TESTED: LARGE ROCK AND SMALL ROCK. SAMPLES WERE OBTAINED FROM THE LAGOON EFFLUENT, THE INFLUENT TO THE EXPERIMENTAL LAGOON AND THE EFFLUENT LEAVING THE LARGE ROCK AND SMALL ROCK FILTERS, AND WERE ANALYZED FOR TOTAL SOLIDS, VOLATILE SUSPENDED SOLIDS, CHEMICAL OXYGEN DEMAND, BIOCHEMICAL OXYGEN DEMAND, AMMONIA, NITROGEN, PHOSPHORUS, CHLOROPHYLL AND PH. IN THE FIRST SIX MONTHS OF OPERATION, THE FIELD SCALE INSTALLATION RESPONDED THE SAME WAY AS THE PILOT SCALE HAD, AS THE BIOLOGICAL SLIME LAYER WAS BECOMING ESTABLISHED ON THE ROCK SURFACES. ONCE THIS WAS ESTABLISHED, THE CAPTURE OF SUSPENDED SOLIDS INCREASED. AERATION FACILITIES MUST BE PROVIDED FOR THE EFFLUENT PART OF THE YEAR. IF THE TOTAL ALKALINITY IS GREATER THAN 260 MG/LITER OF CALCIUM CARBONATE, THERE WILL BE NO ODOR PROBLEM. EFFECTIVE FILTER LIFE SHOULD BE GREATER THAN 20 TO 30 YEARS. ROCK SIZES BETWEEN 2.54 CM AND 12.70 CM WILL MAKE SATISFACTORY FILTERS. MOST ROCKS IN A FILTER SHOULD BE WITHIN A RANGE OF 5 CM. MORE INVESTIGATION IS NEEDED TO INVESTIGATE THE RELATIONSHIP BETWEEN ROCK SIZE AND HYDRAULIC LOADING. TENTATIVE GUIDELINES CAN BE DESIGNED FOR SUBMERGED ROCK FILTERS.

COMBINED INDUSTRIAL AND DOMESTIC WASTE TREATMENT IN WASTE STABILIZATION LAGOONS.
OLSEN, OTMAR D.; VAN VAN HEUVELEN, W.; VENNES, JOHN W.
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, GRAND FORKS, N. DAK.
JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 40, NO 2, P 214-222, FEB 1968. 2 FIG, 6 TAB, 8 REF.
*GRAFTON(N DAK), *MEAT PROCESSING WASTES, *MILK PROCESSING WASTES, *POTATO PROCESSING WASTES, SUSPENDED SOLIDS, TOTAL BACTERIA.
05D
STABILIZATION LAGOONS ARE USED EXTENSIVELY IN NORTH DAKOTA AS A MEANS OF TREATING DOMESTIC WASTES. DEVELOPING INDUSTRIES HAVE BEEN DISCHARGING THEIR WASTES TO THE LOCAL MUNICIPALITIES LAGOON AND CAUSE PROBLEMS. EXISTING DESIGN STANDARDS RECOMMEND AN ORGANIC LOADING RATE OF 20 LBS BOD5/ACRE/DAY WITH PROVISIONS FOR 120 DAYS RETENTION. DURING THE SUMMER MONTHS, LAGOON EFFICIENCY INDICATED THAT LOADINGS OF 200 LBS BOD5/ACRE/DAY COULD BE APPLIED DURING THESE PERIODS. THE APPLICATION OF POTATO WASTES AS WELL AS MEAT PROCESSING AND MILK WASTES TO MUNICIPAL STABILIZATION LAGOONS CAN ELEVATE THE LOADING TO

OVER 250 LBS BOD5/ACRE/DAY RESULTING IN SEVERE NUISANCE CONDITIONS DURING THE SPRING THAW PERIOD. PURPLE SULFUR BACTERIA DEVELOP READILY IN OVERLOADED LAGOONS AS THE TEMPERATURE IS ELEVATED BEYOND 45 DEG F(72 DEG C) AND ANAEROBIC DECOMPOSITION OF THE SETTLED SOLIDS PROMOTES THE PRODUCTION OF HYDROGEN SULFIDE (H2S). IN-PLANT TREATMENT OF THE FOOD PROCESSING INDUSTRY IS ESSENTIAL TO REMOVE THE SETTLEABLE SOLIDS PRIOR TO DISCHARGE TO A LAGOON. THE SUSPENDED SOLIDS ARE A FACTOR IN LAGOON LOADING AS THEY TEND TO DROP OUT DURING THE WINTER FREEZE. (AGUIRRE-TEXAS)

DESIGNING WASTE PONDS TO MEET WATER QUALITY CRITERIA.
OSWALD, WILLIAM J.; MERON, AARON; ZABAT, MARIO D.
CALIFORNIA UNIV., BERKELEY. DEPT. OF SANITARY ENGINEERING AND PUBLIC HEALTH.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 186-194, 3 FIG, 4 TAB, 23 REF.
05D
THE OVERALL PROCESS OF WASTE STABILIZATION IN OXIDATION LAGOONS WAS EXAMINED FROM A LOGICAL DESIGN STANDPOINT. SIGNIFICANT FACTORS WERE EXAMINED FROM THE LITERATURE, AND THESE INCLUDED INFECTIOUS AGENTS, PLANT NUTRIENTS, ORGANIC CHEMICALS, AND LAND EROSION AND SUBSEQUENT ADDITION OF MINERALS, CHEMICALS, AND SILTS, RADIOACTIVE SUBSTANCES, AND HEAT POLLUTION. IN EACH CASE, DESIGN PRACTICES BOTH FROM LITERATURE RESEARCH AND PRACTICAL EXPERIENCE WERE PRESENTED. A SUMMARY OF THE THREE YEARS OF OPERATION OF THE SAINT HELENA WASTE POND SYSTEM IS PRESENTED IN SUPPORT OF THE DESIGN PRACTICES PREVIOUSLY ADVOCATED. WATER QUALITY CONTROL OF A HIGH ORDER IS CONSISTENTLY OBTAINED AT THE SAINT HELENA PLANT, AND THIS CONTROL IS ATTRIBUTED MAINLY TO THESE IMPROVED DESIGN PRACTICES. FURTHER IMPROVEMENT MAY BE POSSIBLE WITH ADDITION OF ALGAE HARVESTING FACILITIES WHICH WILL ALSO REMOVE PHOSPHATES, BUT SINCE THERE IS LITTLE OR NO EFFLUENT FROM THE PONDS NOW THE PRESENT SYSTEM MORE THATN COMPLIES WITH CURRENT STANDARDS.

ALGAE AND WATER POLLUTION
PALMER, C. M.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-287 120, IN PAPER COPY, IN MICROFICHE. REPORT NO EPA-600/9-77-036, DECEMBER 1977. 124 P, 73 FIG, 24 TAB, 283 REF. 1BC611, 68-03-0232.
FIELD 05C, 05D, 05G, 04A
AN UPDATED ENLARGEMENT OF A 1959 MANUAL GIVES GREATER EMPHASIS TO ALGAE ASSOCIATED WITH WATER POLLUTION. NEW CHAPTERS INCLUDE ALGAE IN STREAMS, ALGAE AND EUTROPHICATION, ALGAE AND ESTUARINE POLLUTION, ALGAE AS WATER QUALITY INDICATORS, AND ALGAE IN SEWAGE STABILIZATION PONDS. NEW MATERIAL WAS ADDED TO ORIGINAL CHAPTERS WHICH DEAL WITH THE SIGNIFICANCE AND ECOLOGY OF ALGAE, ALGAL IDENTIFICATION, ALGAE IN LAKES AND RESERVOIRS, ATTACHED ALGAE, CLEAN-WATER ALGAE, ALGAE AND FRESHWATER POLLUTION, TASTE AND ODOR ALGAE, FILTER AND SCREEN-CLOGGING ALGAE, OTHER PROBLEMS CAUSED BY ALGAE (SLIME, COLORATION, TOXICITY, PARASITES, RADIOACTIVITY), ADDITIONAL USES FOR ALGAE (IN INDUSTRY, FOOD FOR FISH, WASTE TREATMENT, MARINE POLLUTION INDICATORS, INDICATORS OF TEMPERATURE, PH, AND TOXICITY), ALGAL ENUMERATION PROCEDURES, AND ALGAL CONTROL. THE REVISED IDENTIFICATION KEY CONTAINS MANY ADDITIONAL SPECIES, AND THE MOST IMPORTANT ARE ILLUSTRATED IN COLOR PLATES. MOST CHAPTERS INCLUDE A SELECTED BIBLIOGRAPHY AND LIST OF TYPICAL ALGAE FOR THE SITUATION UNDER DISCUSSION, AND AN EXTENSIVE BIBLIOGRAPHY IS APPENDED TO THE MANUAL. THE MANUAL IS INTENDED FOR USE BY STAFF OF WATER OR WASTEWATER TREATMENT PLANTS, TO ASSIST THEM IN DIAGNOSING AND REMEDYING PROBLEMS CAUSED BY ALGAE, SUCH AS ODOR, TASTE, AND CLOGGING OF FILTERS. ALGAL CONTROL METHODS ARE DISCUSSED FOR RAW WATER SUPPLIES, RECREATIONAL WATERS AND FISH PONDS, TREATMENT PLANTS, AND DISTRIBUTION SYSTEMS. (LYNCH-WISCONSIN)

ALGAL RECORDS FOR THREE INDIANA SEWAGE STABILIZATION PONDS.
PALMER, C. MERVIN
ROBERT A. TAFT WATER RESEARCH CENTER, CINCINNATI, OHIO. ADVANCED WASTE TREATMENT RESEARCH LAB.
PROCEEDINGS OF THE INDIANA ACADEMY OF SCIENCE, VOL 78, P 139-145, 1968, 3 TAB, 6 REF.
BLUE-GREEN ALGAE, NITZSCHIA, BIOLOGICAL STUDIES, ALGAL IDENTIFICATION.
05D
THREE SEWAGE STABILIZATION PONDS IN SOUTHEASTERN INDIANA WERE AMONG SEVERAL THROUGHOUT THE UNITED STATES SELECTED FOR BIOLOGICAL STUDIES, WITH PARTICULAR EMPHASIS ON THE ALGAL FLORA. ALGAL IDENTIFICATIONS HAVE BEEN RECORDED FROM 376 SAMPLES COLLECTED FROM THE PONDS DURING A PERIOD FROM MAY 1962 TO AUGUST 1968. ALTHOUGH CERTAIN GENERA WERE FOUND FREQUENTLY IN ALL THREE PONDS, EACH POND HAD A DISTINCTIVE ALGAL FLORA. GREEN ALGAE WERE INVARIABLY THE MOST ABUNDANT; HOWEVER, FLAGELLATES WERE ALSO PROMINENT. OF A TOTAL OF 64 GENERA OF THE MOST SIGNIFICANT AND ABUNDANT ALGAE THERE WERE 29 GREEN

ALGAE, 19 FLAGELLATES, 10 BLUE-GREEN ALGAE, AND 6 DIATOMS. SOME GENERA WERE LIMITED TO THE SUMMER SEASON, WHILE OTHERS WERE MOST PROMINENT IN SPRING AND FALL OR IN WINTER. THE POLLUTION-TOLERANT ALGAE, EUGLENA AND NITZSCHIA, WERE ABUNDANT AND PERSISTENT IN ALL THREE PONDS. THE BIOCHEMICAL OXYGEN DEMAND AT THE INTAKES WAS ABOUT 500 PPM AND FOR THE EFFLUENTS LESS THAN 50 PPM. THE FIRST VIRUS INFECTING A BLUE-GREEN ALGA WAS ISOLATED FROM ONE OF THE PONDS IN RIPLEY COUNTY. (JONES-WISCONSIN)

EFFECTS OF DETERGENT PROTEASE ENZYMES ON SEWAGE OXIDATION POND PHYTOPLANKTON.
PARKER, D. C.; SAMSEL, G. L.; ODENG-ASAMOA, E. K.
VIRGINIA POLYTECHNIC INST., BLACKSBURG. DEPT. OF BIOLOGY.
BIOSCIENCE, VOL 21, NO 20, P 1035-1042, OCTOBER 15, 1971. 4 FIG, 4 TAB, 15 REF.
*PROTEASE ENZYMES, CHLOROGONIUM, DOCYSTIS, OSCILLATORIA, SPIRULINA, PANDORINA, PHACUS, STAURASTRUM, TRACHELOMONAS.
05C
FIELD INVESTIGATIONS ON THE EFFECTS OF DETERGENT PROTEASE ENZYMES ON ALGAL COMMUNITIES OF SEWAGE OXIDATION PONDS SUGGEST THAT ADDITIONS UP TO 1.0 MG/L CAUSE ONLY RELATIVELY SMALL CHANGES IN PHYTOPLANKTON POPULATIONS AND ALGAL COMMUNITY STRUCTURE. AS CONCENTRATIONS APPROACH 10 MG/L, THE COMMUNITY STRUCTURE MIGHT BE DISTURBED SIGNIFICANTLY IN SOME PONDS, DEPENDING ON THE PARTICULAR ENZYME PREPARATION. ENZYME PREPARATIONS NUMBERS 1 AND 2 (EP-1 AND EP-2) FROM THE SOAP AND DETERGENT ASSOCIATION WERE USED IN CONCENTRATIONS OF 10, 1.0, AND 0.1 MG/L ON SEVERAL BIOASSAY SYSTEMS. EITHER ONE LITER, OPEN POLYETHYLENE BAGS, FLOATING AT THE SURFACE IN POLYSTYRENE FRAMES, OR TRANSPARENT ACRYLIC PLASTIC CYLINDERS, WITH THEIR BASES STUCK IN THE MUD AND TOPS PROTRUDING ABOVE THE WATER LINE, WERE USED IN SAMPLING. EP-2 FAVORED GROWTH OF BLUE-GREEN ALGAE, INDICATING THAT WIDESPREAD USE OF SUCH PREPARATIONS SHOULD BE AVOIDED. (MORTLAND-BATTELLE)

FOOD CANNERY WASTE TREATMENT BY LAGOONS AND DITCHES AT SHEPPARTON, VICTORIA, AUSTRALIA.
PARKER, C. D.
MELBOURNE WATER SCIENCE INST. (AUSTRALIA).
PROCEEDINGS, INDUSTRIAL WASTE CONFERENCE, 21, VOL 1, NO 2, MARCH 1966, P 284-302, 5 FIG, 13 TAB, 6 REF.
SHEPPARTON(AUSTRALIA), OXIDATION DITCHES, SOUP, FOOD WASTES.
05D
CANNERY WASTE IS CHARACTERIZED BY HIGH BOD AND HIGH ACIDITY. THE USUAL METHOD OF TREATMENT IS SPRAY OR FLOOD IRRIGATION OR AEROBIC TYPE LAGOONS WITH HEAVY DOSAGE OF SODIUM NITRATE FOR ODOR CONTROL. IN SHEPPARTON, VICTORIA, EXPANSIONS IN THE FACILITIES OF SHEPPARTON PRESERVING COMPANY, THE LARGEST CANNERY IN THE SOUTHERN HEMISPHERE, AND THE BUILDING OF A SOUP CANNERY IN THE AREA CAUSED PROBLEMS IN THE TREATMENT OF THE RESULTING SEWAGE. THERE WAS A PRESSING NEED FOR AN EFFICIENT MEANS OF PURIFYING, WITHOUT CAUSING NUISANCE, THE LARGE SEASONAL FLOWS OF HIGHLY POLLUTED FOOD WASTES FROM TWO CANNERIES ON AREAS CLOSELY ADJACENT TO A PROSPEROUS AND RAPIDLY DEVELOPING URBAN CENTER. THE SHORT SEASONAL NATURE OF CANNERY OPERATIONS AND CONSEQUENT HIGH CAPITAL COST MADE THE PROBLEM EVEN MORE DIFFICULT. IT WAS DECIDED TO EXPERIMENT WITH ANAEROBIC AND AEROBIC TYPE LAGOONS AND OXIDATION DITCHES. THE WASTE FROM EACH FIRM IS MIXED WITH SEWAGE PLANT EFFLUENT AND TREATED IN THE NEW PROCESSING UNIT WITH VERY GOOD RESULTS WHICH ARE DESCRIBED IN GREAT DETAIL. THE TOTAL COST OF THE NEW UNIT, EXCLUDING THE COST OF INFLOW AND OUTFLOW PIPELINES AND LABOR AND MAINTAINENCE, WAS $155,000 TO THE PRESERVING CO., AND $143,000 (AMERICAN DOLLARS) TO THE SOUP CANNERY PLUS ANNUAL COSTS OF $5,364 AND $8,192 RESPECTIVELY, EXCLUDING PIPELINES, PUMPING STATIONS, AND MAINTAINENCE LABOR. THE NET RESULT WAS ALMOST COMPLETE PURIFICATION AT COSTS THE INDUSTRIES COULD ACCEPT. (LOWRY-TEXAS)

WASTEWATER TREATMENT FOR SMALL RURAL COMMUNITIES
PARKER, C. E.
VIRGINIA UNIV., CHARLOTTESVILLE. DEPT. OF CIVIL ENGINEERING.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA. 22161 AS PB-290 904, IN PAPER COPY, IN MICROFICHE. VIRGINIA WATER RESOURCES RESEARCH CENTER, VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY, BLACKSBURG. COMPLETION REPORT, 1973. 15 P, 2 FIG, 2 TAB, 10 REF. OWRT-A-052-VA(1).
FIELD 05D
A LABORATORY STUDY USING ALGAL GROWTH UNITS WAS USED TO DETERMINE THE PARAMETER RESPONSIBLE FOR FLOTATION OF ALGAL CELLS COAGULATED WITH ALUMINUM SULFATE. THE EFFECT OF MIXING WAS ALSO STUDIED AND THESE RESULTS WERE USED TO EVALUATE PROCESS DESIGN FOR CHEMICALLY TREATED LAGOON EFFLUENT. IN ADDITION, COST COMPARISONS BETWEEN EXTENDED AERATION WITH CHEMICAL-PHYSICAL TREATMENT AND LAGOON TREATMENT FOLLOWED BY THE CHEMICAL-PHYSICAL TREATMENT WERE MADE. DISSOLVED OXYGEN WAS FOUND TO BE THE PARAMETER THAN CAN BE USED TO CONTROL SEDIMENTATION UNDER FIELD OPERATING CONDITIONS. BY MAINTAINING A LAGOON

EFFLUENT WITH DISSOLVED OXYGEN LESS THAN 50% SATURATION. SEDIMENTATION CAN BE ASSURED. MIXING VARIATIONS DID NOT APPRECIABLY AFFECT THE ABILITY TO FLOAT, ONLY THE TIME REQUIRED TO PRODUCE FLOTATION. DESIGN PARAMETERS USED IN CONVENTIONAL WATER TREATMENT PLANT DESIGN SEEM TO BE REASONABLE FOR DESIGNING ALGAL COAGULATION, SEDIMENTATION, AND FILTRATION FACILITIES. THE USE OF LAGOONS FOLLOWED BY CHEMICAL-PHYSICAL TREATMENT IS COMPARABLE ECONOMICALLY TO EXTENDED AERATION TREATMENT UP TO A POPULATION OF 500. FOR POPULATIONS UP TO 5000 LAGOON-CHEMICAL-PHYSICAL TREATMENT WILL RESULT IN AN INITIAL COST BURDEN 50% LESS THAN EXTENDED AERATION FOLLOWED BY CHEMICAL-PHYSICAL TREATMENT. THEREFORE, WHERE PHOSPHORUS AND NITROGEN REDUCTIONS ARE DESIRABLE, LAGOON-CHEMICAL-PHYSICAL TREATMENT OFFERS A CONSIDERABLE ECONOMIC ADVANTAGE TO THE SMALL COMMUNITY.

AN EVALUATION OF THREE COMBINED SEWER OVERFLOW TREATMENT ALTERNATIVES,
PARKS, J. W.
CLARK, DIETZ, AND ASSOCIATES, URBANA, ILL.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161, AS PB-239 115, $5.25 IN PAPER COPY, $2.25 IN MICROFICHE. ENVIRONMENTAL PROTECTION AGENCY, REPORT EPA-670/2-74-079, DECEMBER, 1974. 112 P, 32 FIG, 20 TAB, 2 APPEND. EPA PROJECT 11020 FAM PROGRAM ELEMENTS 1DP034.
WET WEATHER DISCHARGE, ORGANIC LOADING.
05D
THREE SYSTEMS FOR THE TREATMENT OF COMBINED SEWER OVERFLOW IN SHELDYVILLE, ILLINOIS, WERE EVALUATED FOR INFLUENT AND EFFLUENT FLOW, BOD, AND SUSPENDED SOLIDS. THESE WERE A SINGLE-CELL FLOW-THROUGH LAGOON, A RETENTION LAGOON FOLLOWED BY A TWO-CELL FACULTATIVE LAGOON SYSTEM AND EFFLUENT CHLORINATION, AND A SEDIMENTATION TANK WITH INFLUENT CHLORINATION. EACH ALTERNATIVE UNIT WAS FOUND TO BE EFFECTIVE IN REDUCING THE MEASURED POLLUTIONAL DISCHARGES DURING WET WEATHER CONDITIONS. PARTIAL SEPARATION OF THE COMBINED SEWERS ALSO WAS SUCCESSFUL IN REDUCING THE ORGANIC LOADING DURING PERIODS OF COMBINED SEWER OVERFLOW. A DETAILED ANALYSIS WAS PRESENTED OF THE TWO-CELL FACULTATIVE LAGOON AS A TERTIARY TREATMENT SYSTEM FOR THE EXISTING SEWAGE TREATMENT PLANT EFFLUENT. DATA ON THE OPERATION OF THE UNITS WAS COLLECTED ONLY DURING APRIL AND MAY, AND IT WAS RECOMMENDED THAT THESE TREATMENT UNITS BE FURTHER TESTED FOR SEASONAL VARIATION IN RUNOFF WHICH MIGHT AFFECT UNIT PERFORMANCE. DESIGN CRITERIA IN SELECTING AND SIZING COMBINED SEWER OVERFLOW TREATMENT UNITS SHOULD BE BASED ON THE EXPECTED FIRST FLUSH CHARACTERISTICS, RUNOFF INTENSITIES, AND INFLUENT SEWER HYDRAULIC CAPACITIES. (KRAMER-FIRL)

WATER POLLUTION CONTROL AT THE ROHM AND HAAS HOUSTON PLANT,
PARROT, J. W.; SMITH, W. M.
ROHM AND HAAS CO., DEER PARK, TEX.
WATER AND SEWAGE WORKS, VOL 118, NO 1, P IW/4-IW/8, JAN 1971. 8 FIG, 4 TAB.
POLYMERS, COMPOSITING, *HOUSTON(TEX).
05D
THE HOUSTON PLANT OF ROHM AND HAAS COMPANY IS AN ORGANIC CHEMICAL PRODUCING PLANT. IT HAS EXPANDED ITS TREATMENT FACILITIES THREE TIMES IN ELEVEN YEARS. THE LATEST OF THESE EXPANSIONS INCLUDED 3 MILLION GALLON AERATED LAGOONS WITH 1500 HP OF FLOATING AERATORS. THE LAGOONS TREAT 1400 GPM WASTE WATER WHICH IS A COMPLEX OF SALT AND ORGANIC COMPOUNDS. A CHROMATOGRAM OF A TYPICAL SAMPLE SHOWS 14 DIFFERENT PEAKS. A DISCUSSION OF THE COD LOAD IS PRESENTED WITH ILLUSTRATIVE GRAPHS. THE TREATMENT FACILITIES CONSIST OF WATER COLLECTION, PRIMARY FACILITIES (OIL AND SLUDGE SEPARATION, COMPOSITING, NEUTRALIZATION) AND SECONDARY (BIOLOGICAL) UNITS WHICH ARE ILLUSTRATED IN THE FLOWSHEET. DISCUSSION OF THE VARIOUS UNITS IS PRESENTED. THE AERATED LAGOONS WERE SELECTED IN ORDER TO OBTAIN RELATIVELY LOW SUSPENDED SOLIDS. THE TOTAL CAPITAL INVESTMENT IN WASTE WATER HANDLING INCLUDING SEWER SYSTEM, WATER TREATMENT PLANT AND WASTE OIL FACILITIES IS ABOUT $3,300,000. THE COST OF WASTE TREATMENT EXCLUDING DEPRECIATION IS ABOUT $.014/LB OF COD REMOVAL OR $0.53/1000 GAL. OF WATER PROCESSED. DISPOSAL OF OILY WASTES INCLUDING DEPRECIATION IS $0.035 GAL. (RAYAAN-TEXAS)

STATE-OF-THE-ART TREATMENT OF WASTES GENERATED BY THE PULP AND PAPER INDUSTRY
PATRIE, B. A.; PARKER, W. H., III.
JORDAN (EDWARD C.) CO., INC., PORTLAND, ME.
NEW ENGLAND WATER POLLUTION CONTROL ASSOCIATION JOURNAL, VOL. 10, NO. 2, P 145-165, OCTOBER, 1976. 4 FIG, 2 REF, 5 TAB.
FIELD 05D
THIS DISCUSSION OF EFFLUENT TREATMENT METHODS IS DIRECTED TOWARD THE KRAFT MILL. WITH SOME MODIFICATIONS THESE METHODS MAY ALSO BE ECONOMICALLY APPLIED TO THE NEUTRAL SULFITE SEMICHEMICAL AND

SULFITE PROCESSES IN WHICH SOME FORM OF CHEMICAL RECOVERY AND COMBUSTION OF BLACK LIQUOR RESIDUES IS PRACTICED. SAVEALLS AND CLARIFICATION ARE USED FOR PRIMARY TREATMENT IN KRAFT MILLS; BOD REDUCTION METHODS INCLUDE AERATED STABILIZATION BASINS, ACTIVATED SLUDGE TREATMENT, AND ROTATING BIOLOGICAL SURFACE (DISK) SYSTEMS. ULTIMATE SLUDGE DISPOSAL IS BY LAND DISPOSAL, INCINERATION, OR AND EXTERNAL TREATMENT METHODS. INTERNAL TECHNIQUES INCLUDE THE RAPSON PROCESS (COMPLETELY CLOSED PULP BLEACHING AND CHEMICAL RECOVERY SYSTEM), PROCESSES TO REPLACE KRAFT PULPING, INTERNAL SPILL CONTROL, ALTERATION OF THE BLEACHING SEQUENCE, AND OXYGEN BLEACHING. EXTERNAL TREATMENT METHODS FOR COLOR REDUCTION INCLUDE LIME TREATMENT, LIME MUD TREATMENT, AND ALUM COAGULATION AND PRECIPITATION. ADVANCED WASTE WATER TREATMENT SYSTEMS FOR REMOVAL OF TURBIDITY, COLLOIDAL AND SUSPENDED SOLIDS, DISSOLVED SALTS AND SOLIDS, REFRACTORY ORGANICS, AND NUTRIENTS INCLUDE COAGULATION AND FLOCCULATION FOLLOWED BY SETTLING; SAND OR MIXED-MEDIA FILTRATION; REVERSE OSMOSIS, AMMONIA STRIPPING, BIOLOGICAL NITRIFICATION-DENITRIFICATION; ION-EXCHANGE; ACTIVATED CARBON TREATMENT, CHLORINATION; AND OZONIZATION. (WITT-IPC)

EVALUATION OF AERATED LAGOONS AS A SEWAGE TREATMENT FACILITY IN THE CANADIAN PRAIRIE PROVINCES.
PICK, R.; BURNS, G. E.; VAN ES, D. W.; GIRLING, R. M.
METROPOLITAN CORP. OF GREATER WINNIPEG (MANITOBA). WATER WORKS AND WASTE DISPOSAL DIV.
IN: INTERNATIONAL SYMPOSIUM ON WATER POLLUTION CONTROL IN COLD CLIMATES, JULY 22-24, 1970, UNIVERSITY OF ALASKA, COLLEGE, P 191-212. 13 FIG, 3 TAB, 6 REF.
*WINNIPEG(MANITOBA), NUTRIENT REMOVAL, SURFACE AERATORS.
05D;05C
A TWO-YEAR STUDY OF AERATED LAGOONS WAS UNDERTAKEN BECAUSE THERE WAS LITTLE DOCUMENTED INFORMATION ON THEIR OPERATION UNDER CANADIAN PRAIRIE CONDITIONS. IN ORDER TO ASSESS THE APPLICABILITY OF THIS PROCESS FOR TREATMENT OF DOMESTIC WASTES, THREE PILOT AEROBIC-ANAEROBIC AERATED LAGOONS WERE CONSTRUCTED DURING THE SUMMER AND FALL OF 1967 IN THE CORNER OF AN EXISTING STABILIZATION POND FOR DOMESTIC SEWAGE TREATMENT FROM A SEPARATE SYSTEM. AERATED LAGOONS WERE FOUND TO BE CAPABLE OF PROVIDING 'SECONDARY EQUIVALENT' SEWAGE TREATMENT. UNDER PRAIRIE CLIMATIC CONDITIONS THERE IS A PROBLEM OF SLUDGE ACCUMULATION LEADING TO DECLINING EFFICIENCY OF BOD REMOVAL AND A REDUCTION IN THE DISSOLVED OXYGEN CONCENTRATION DURING THE SUMMER MONTHS. THE ECONOMIC FEASIBILITY OF AERATED LAGOONS IS QUESTIONABLE UNTIL THE EXTENT AND COST IMPLICATIONS OF THE SLUDGE PROBLEM ARE FULLY DEFINED BY FURTHER RESEARCH AND EXPERIENCE. USE OF SURFACE AERATORS UNDER PRAIRIE WINTER CONDITIONS IS NOT PRACTICAL DUE TO ICE BUILD-UP. CONCLUSIONS ARE THAT AERATED LAGOONS ARE AN EFFECTIVE MEANS OF PROVIDING SECONDARY TREATMENT BUT SOME PROVISION MUST BE MADE FOR SLUDGE HANDLING.

SEWAGE FROM THE TAP-CONCLUSION.
PICKFORD, J. A.
LOUGHBOROUGH UNIV. OF TECHNOLOGY (ENGLAND). DEPT. OF CIVIL ENGINEERING.
EFFLUENT AND WATER TREATMENT JOURNAL, VOL 9, NO. 10, P 559-562, OCTOBER, 1969, 1 FIG, 7 REF.
*GREAT BRITAIN, MICROSTRAINERS, SAND FILTRATION, LOADING RATES, PEBBLE-BED CLARIFIERS.
05D
PAPERS AND RELATED DISCUSSIONS PRESENTED AT THE SECOND PUBLIC HEALTH CONFERENCE AT LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY WERE REVIEWED AND SUMMARIZED. TERTIARY TREATMENT PROCESSES IN BRITAIN HAVE BEEN DESIGNED FOR THE REMOVAL OF SUSPENDED SOLIDS AND THEIR ASSOCIATED BOD. UNIT PROCESSES UTILIZED HAVE BEEN SETTLEMENT IN LAGOONS, STATIC FILTRATION AS IN SAND FILTERS AND MECHANICAL FILTRATION AS IN MICROSTRAINERS. GRASS PLOTS IN WHICH A COMBINATION OF SETTLEMENT AND FILTRATION TAKES PLACE HAVE ALSO BEEN USED. LAGOONS WITH A RETENTION TIME OF 17 DAYS GAVE A FINAL DISCHARGE CONTAINING ONLY 3 MG/1 SUSPENDED SOLIDS. GRASS PLOTS WHEN LOADED AT 1 M3/M2/DAY REMOVED 76% OF THE SUSPENDED SOLIDS AND 55% OF THE BOD. RAPID SAND FILTERS HAVE YIELDED 70-80% REMOVAL OF SUSPENDED SOLIDS AT FLOW RATES RANGING BETWEEN 118 AND 235 M3/M2/DAY. TWO NEW TYPES OF RAPID SAND FILTERS WERE DISCUSSED, THE IMMEDIUM AND THE SIMATER FILTERS. THE IMMEDIUM HAS DEALT WITH FLOWS UP TO 470 M3/M2/DAY REDUCING A SUSPENDED SOLIDS CONCENTRATION OF 17 MG/1 TO 9 MG/1. AT A RATE OF 300 M3/M2/ DAY THE 17 MG/1 CONCENTRATION WAS REDUCED TO 5 MG/1. REDUCTION OF 50-60% OF THE SUSPENDED SOLIDS WAS ACCOMPLISHED BY A PEBBLE-BED CLARIFIER USING 5-10 MM MEDIUM AND A FLOW RATE OF 24 M3/M2/DAY. BACTERIAL REDUCTIONS FROM SECONDARY EFFLUENTS IN THE ABOVE METHODS WERE ALSO REPORTED. ESTIMATED COSTS FOR TERTIARY TREATMENT RANGED FROM 6 TO 20% OF CONVENTIONAL PRIMARY AND SECONDARY TREATMENT. (GALWARDI-TEXAS)

PERFORMANCE OF RAW WASTE STABILIZATION LAGOONS IN MICHIGAN WITH LONG PERIOD STORAGE BEFORE DISCHARGE.
PIERCE, D. M.
ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, D.C.
IN: UPGRADING WASTEWATER STABILIZATION PONDS TO MEET NEW DISCHARGE STANDARDS, AUGUST 21-23, 1974.

LOGAN, UTAH, UTAH STATE UNIVERSITY, P 89-135, 4 FIG, 15 TAB, 9
RAW WASTE STABILIZATION LAGOONS, LONG PERIOD STORAGE, CONTROL SHORT PERIOD DISCHARGE.
05D
CONDITIONS UNDER WHICH SECONDARY TREATMENT REQUIREMENTS COULD BE MET BY RAW WASTE STABILIZATION LAGOONS ARE DETERMINED. FORTY NINE MUNICIPAL LAGOON SYSTEMS TYPIFYING FEATURES OF CONSTRUCTION, LOADINGS, AND MAINTENANCE AND OPERATIONAL PRACTICES WHICH READILY ACCOMODATE A COMMON MODE INVOLVING LONG PERIOD STORAGE FOLLOWED BY CONTROL SHORT PERIOD DISCHARGE WERE CHOSEN IN MICHIGAN. RECORDS FROM THE FORTY NINE PLANTS WERE REVIEWED AND RECORDED FOR ANALYSES OF BOD AND SUSPENDED SOLIDS. THESE DATA WERE ANALYZED STATISTICALLY IN TERMS OF PROBABILITY OF OCCURRENCE. IN-DEPTH STUDIES WERE MADE OF FECAL COLIFORM DATA TO DETERMINE SEASONAL TRENDS IN THEIR LEVELS. NO RELATIONSHIP WAS FOUND BETWEEN FECAL COLIFORM LEVELS AND BOD AND SUSPENDED SOLIDS LEVELS. RESULTS SHOWED THAT THE LAGOONS STUDIED CAN CONSISTENTLY PRODUCE EFFLUENTS MEETING EPA REQUIREMENTS FOR BOD AND FECAL COLIFORMS AND CAN GENERALLY MEET STANDARDS FOR SUSPENDED SOLIDS. SUPPLEMENTARY STUDIES WERE UNDERTAKEN: TO EVALUATE PERFORMANCE OF RAW WASTE STABILIZATION LAGOONS IN OTHER NORTHERN STATES WHEN MANAGED IN SIMILAR WAYS; TO EXAMINE THE METHODS IN USE AND RESULTS OF CHLORINATION FOR COLIFORM BACTERIA DESTRUCTION BOTH AT LAGOONS SO MANAGED AND THOSE WITH CONTINUOUS DISCHARGE; AND TO COLLECT AVAILABLE DATA ON NITRIFICATION PHENOMENA. OTHER RAW WASTE STABILIZATION LAGOONS WITH LONG PERIOD STORAGE AND INTERMITTENT DISCHARGE WERE STUDIED IN MINNESOTA; NORTH DAKOTA; UPPER PENNINSULAR, MICHIGAN; AND BELDING, MICHIGAN. CHLORINATION AT CONTINUOUS DISCHARGE STABILIZATION LAGOONS WAS STUDIED IN CHESTERFIELD TOWNSHIP, MICHIGAN AND ILLINOIS. CHLORINATION OF LAGOON CONTENTS, LAGOONS FOLLOWING SECONDARY TREATMENT, AND AERATED LAGOONS WERE ALSO STUDIED.

A RATIONAL APPROACH TO THE DESIGN OF AERATED LAGOONS.
POHL, EDWARD F.
CORPS OF ENGINEERS, ANCHORAGE, ALASKA. SANITARY AND CIVIL ENGINEERING SECTION.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 231-243, 9 FIG, 3 TAB, 26 REF.
*AERATED LAGOONS, SUSPENDED SOLIDS.
05D
THE VARIOUS PARAMETERS INVOLVED IN THE DESIGN OF AERATED LAGOONS WERE INVESTIGATED WITH PARTICULAR REFERENCE TO THE USE OF AIR DIFFUSED INTO THE LAGOON THROUGH LENGTHS OF TUBING. IT WAS DETERMINED THAT A DESIGN FOR AN AERATED LAGOON SHOULD EVOLVE IN THREE STAGES, EACH TO BE EVALUATED FOR SUMMER AND WINTER CONDITIONS. TO DESIGN AN AERATED LAGOON, THE FIRST STAGE INVOLVES EVALUATION OF THE RECEIVING BODY BY BOTH THE WASTE PRODUCERS, AND THE AGENCY RESPONSIBLE FOR THE PROTECTION OF THE QUALITY OF THE RECEIVING WATER. THE REQUIRED EFFLUENT QUALITY DETERMINATION IS BASED ON BOD, SUSPENDED SOLIDS, EFFLUENT COLIFORM ORGANISM COUNT. DETERMINATION OF THE DETENTION TIME REQUIRED TO ACHIEVE THE STAGE I OBJECTIVES IS THE SECOND STAGE, AND THE FINAL STAGE INVOLVES AN EVALUATION OF THE OXYGEN NEEDED TO SUPPLY BOTH THE AERATION TANK MIXED LIQUOR SOLIDS RESPIRATION, AND THE BENTHAL OXYGEN DEMAND. CONSERVATIVE OVERALL DESIGN VALUES ARE RECOMMENDED BECAUSE OF THE GAPS IN THE RESEARCH DATA. UNTIL MORE RESEARCH HAS BEEN DONE TO INVESTIGATE THE CONSTANTS AND THE MECHANISMS OF THE PROCESS, CONSERVATIVE ESTIMATES WILL CONTINUE TO BE RECOMMENDED IN ORDER TO PROVIDE A LARGER MARGIN OF SAFETY.

FIELD STUDIES ON STABILIZATION PONDS IN SOUTH INDIA.
PURUSHOTHAMAN, KRISHNIER
MISSOURI UNIV., ROLLA, DEPT. OF CIVIL ENGINEERING.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 80-88, 5 FIG, 7 TAB, 9 REF.
*INDIA, DETENTION TIME, SUSPENDED SOLIDS.
05D
FOUR EXPERIMENTAL WASTE STABILIZATION PONDS WERE CONSTRUCTED AT THE COLLEGE OF ENGINEERING, GUINDY, MADRAS, INDIA. SAMPLES OF THE EFFLUENT AND INFLUENT WERE OBTAINED PERIODICALLY, AND ANALYZED FOR BOD, PH, AND DISSOLVED OXYGEN. THE DATA WAS THEN RECORDED AND STUDIED TO OBTAIN INFORMATION ON ORGANIC AND HYDRAULIC LOADING, DETENTION TIME, DISSOLVED OXYGEN, AND OTHER PARAMETERS NECESSARY IN DETERMINING DESIGN CRITERIA AND LAGOON PERFORMANCE. FROM THE PREVIOUSLY DESCRIBED TESTS, IT WAS FOUND THAT (1) WHEN CLIMATIC CONDITIONS ARE FAVORABLE, LAGOON LOADING CAN BE INCREASED TO AS MUCH AS 400% OF THE NORMAL LOADING RATES, (2) POND DEPTH HAS NO INFLUENCE ON OPERATING EFFICIENCY UNDER THE CONDITIONS STUDIED, (3) BOD REMOVAL EFFICIENCY WAS NOT AFFECTED BY VARYING THE DETENTION TIME FROM 2 TO 9 DAYS, (4) DISSOLVED OXYGEN WAS AS MUCH AS 400% SUPERSATURATED DURING THE DAY, BUT DECREASED TO ZERO AT NIGHT, (5) BACTERIA AND COLIFORM REDUCTIONS WERE NOT AFFECTED BY VARYING EITHER DEPTH, DETENTION, OR BOTH, AND (6) NO CORRELATION WAS DISCOVERED BETWEEN ORGANIC LOADING RATE, AND THE PREDOMINANT PHYTO-AND ZOO-PLANKTONS.

MASS CULTURING OF ALGAE IN CONTROLLED LIGHT-DARK DETENTION SYSTEMS: I. EFFECTS OF CULTURE DENSITY.
PYPER, G. R.; WEBER, W. J., JR.; BORCHARDT, J. A.
NORWICH UNIV., NORTHFIELD, VT. DEPT. OF CIVIL ENGINEERING.
PROCEEDINGS, INDUSTRIAL WASTE CONFERENCE, 21ST, MAY 3, 4, AND 5, 1966, P 1003-1020, 8 FIG, 2 TAB, 20 REF, USPHS RES. GRANT WP-00155.
*NUTRIENT REMOVAL, CONTINUOUS FLOW SYSTEM.
05C;05G
THE POLLUTION-ACCELERATED AGING OF SURFACE WATERS HAS BECOME A MATTER OF CONCERN OVER THE PAST SEVERAL YEARS. CONTINUING INCREASES IN THE VOLUMES OF WASTEWATER INDICATE THAT MORE THOROUGH PURIFICATION OF THESE DISCHARGES MAY BE THE ONLY FEASIBLE MEASURE FOR THE PROTECTION OF OUR NATURAL WATERS. AQUATIC PLANTS CAN BE UTILIZED IN LAGOONS TO EXTRACT PHOSPHORUS AND NITROGEN FROM WASTEWATERS PRIOR TO DISCHARGE TO THE RECEIVING WATER. LABORATORY STUDIES HAVE BEEN MADE ON THE ALGAL GROWTH RATES AND YIELDS AS A FUNCTION OF DARK TO LIGHT RATIOS AND AS A FUNCTION OF ALGAL CONCENTRATION. THE GENERAL CONCLUSIONS ARE: (1) MASS CULTURES OF ALGAE CAN BE GROWN IN A CONTINUOUS SYSTEM CONSISTING OF A DARK RESERVOIR FROM WHICH THE CULTURE CAN BE CIRCULATED THROUGH A LIGHT CELL; (2) THERE IS A MAXIMUM LIGHT UTILIZATION RATE WHICH GIVES A MAXIMUM YIELD WITH RESPECT TO DARK TO LIGHT DETENTION TIMES; (3) GROWTH RATE VARIES LINEARLY WITH DARK TO LIGHT RATIOS OVER A BROAD RANGE OF VALUES; (4) NUTRIENT REMOVAL CHARACTERISTICS ARE NOT ADVERSELY AFFECTED BY LIGHT AND DARK CULTURING SYSTEMS; (5) NUTRIENT REMOVAL APPEARS TO BE A FUNCTION OF CULTURE DENSITY; (6) CURRENT WORK IS ONLY A BEGINNING AND MUST BE EXTENDED; AND (7) A MAJOR FACTOR TO BE STUDIED IS THE EFFECT OF FLOW VELOCITY THROUGH THE LIGHT CELL.

INTRODUCTION TO WASTEWATER TREATMENT PROCESSES.
RAMALHO, R. S.
LAVAL UNIV., QUEBEC.
ACADEMIC PRESS (NEW YORK, SAN FRANCISCO, LONDON). 1977. 409 P.
05D;03E
THE 8 CHAPTERS OF THIS TEXTBOOK DEAL WITH THE CHARACTERIZATION (BOD, ETC.) OF DOMESTIC AND INDUSTRIAL WASTE WATERS; THE THEORY AND PRACTICE OF EFFLUENT AERATION (OXYGEN TRANSFER KINETICS, AIR DIFFUSION, TURBINE AND SURFACE AERATORS, ETC.); PRETREATMENT AND PRIMARY TREATMENTS (SCREENING, SEDIMENTATION, FLOTATION, NEUTRALIZATION); ACTIVATED SLUDGE AND OTHER AEROBIC SECONDARY TREATMENTS (EXTENDED AERATION OR TOTAL OXIDATION, AERATED LAGOONS, STABILIZATION PONDS, TRICKLING FILTERS); ANAEROBIC TREATMENT; SLUDGE PROCESSING (THICKENING, DEWATERING, PRESSURE AND VACUUM FILTRATION, CENTRIFUGATION, DIGESTION, ETC.) AND DISPOSAL; TERTIARY TREATMENTS (SUSPENDED SOLIDS REMOVAL, CARBON ADSORPTION, ION-EXCHANGE, REVERSE OSMOSIS, ELECTRODIALYSIS, CHLORINATION, OZONIZATION, NUTRIENT REMOVAL, ETC.); AND THE GENERAL ECOLOGICAL, ECONOMIC, AND ENGINEERING ASPECTS OF WATER POLLUTION ABATEMENT AND WATER REUSE. A SUBJECT INDEX IS APPENDED, AND STUDENT PROBLEMS AND FURTHER READING REFERENCES ARE GIVEN AFTER EACH CHAPTER.

ALGAL PERIODICITY AND WASTE RECLAMATION IN A STABILIZATION POND ECOSYSTEM.
RASCHKE, RONALD L.
IOWA STATE UNIV., AMES.
JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 42, NO 4, P 518-530, APRIL 1970, 2 FIG, 6 TAB, 40 REF.
*WATER RECLAMATION, VARIATIONS, COMPOSITION.
05D
IN AN ATTEMPT TO EVALUATE POSSIBLE PROCEDURES FOR MEETING NEW STANDARDS OF THE FEDERAL WATER QUALITY ACT, THE AMES WATER POLLUTION CONTROL DEPARTMENT BUILT A NUMBER OF EXPERIMENTAL PONDS. ONE OF THEM WAS MADE AVAILABLE FOR THE PRESENT INVESTIGATION IN WHICH THE INTENT HAS BEEN TO STUDY ALGAL COMPOSITION AND PERIODICITY, DISSOLVED OXYGEN, PH, TEMPERATURE, AND THE EXTENT OF REDUCTION IN 5-DAY BOD, COD, SOLIDS, PHOSPHATES, AMMONIA, AND NITRATES THROUGH THE PLANT POND COMPLEX. THE POND IS 0.12 ACRES IN AREA WITH A WATER HOLDING CAPACITY OF 105, 562 GALLONS AND AN AVERAGE DEPTH OF 2.53 FEET. THE POND DETENTION TIME RANGED BETWEEN 3.7 TO 4.2 DAYS. RESULTS SHOWED THAT ALGAL PERIODICITY AND BOD ANALYSIS MAY BE INFLUENCED BY ALGAL INHIBITORS. GREEN FAGELLATES DOMINATED IN WINTER AND SPRING, WHILE COCCOID GREENS DOMINATED IN SUMMER AND FALL. THE MAXIMUM PER CENT REMOVAL AT ANY ONE TIME WAS 78% AND 75% FOR BOD AND FILTERED BOD RESPECTIVELY. THE MAXIMUM COD REMOVAL WAS 63%. TOTAL SUSPENDED SOLIDS RANGED FROM 458 TO 687 WHICH IS LESS THAN A LIMIT OF 1000 MG/L SET BY THE U.S. PUBLIC HEALTH SERVICE STANDARDS. AMMONIA NITROGEN RANGED FROM 0.0 TO 21.0 MG/L AND NITRATE NITROGEN RANGED FROM 0.5 TO 1.8 MG/L. PH RANGED FROM 7.35 TO 9.09 AND TEMPERATURE FROM 0.8 DEG C TO 29.9 DEG C. THE EFFLUENT USUALLY MET THE IOWA WATER POLLUTION CONTROL COMMISSION'S STANDARDS FOR TEMPERATURE, PH, DISSOLVED OXYGEN CONCENTRATION, BUT PHOSPHORUS AND NITROGEN CONTENTS WERE HIGH. (HANCUFF-TEXAS)

NITROGEN OXIDATION AND REMOVAL EFFICIENCY USING ACTIVATED ALGAE
REGAN, R. W.; MCKINNEY, R. E.
PENNSYLVANIA STATE UNIV., UNIVERSITY PARK. DEPT. OF CIVIL ENGINEERING.
PROGRESS IN WATER TECHNOLOGY, VOL. 8, NO. 4/5, P 451-466, 1977. 9 FIG, 4 TAB, 12 REF.
FIELD 05D
THE USE OF ACTIVATED ALGAE FOR WASTE TREATMENT, IN WHICH FLOCCULATED ALGAE ARE SEPARATED FROM THE EFFLUENT AND RETURNED TO THE PROCESS VESSEL, HAS BEEN UNDER STUDY AT KANSAS UNIVERSITY SINCE 1965. THIS PAPER INVESTIGATES THE OPERATING LIMITS OF THE PROCESS IN TREATING DOMESTIC WASTEWATER WITH ACTIVATED ALGAE IN STABILIZATION PONDS. CONTROL PARAMETERS INCLUDED LIGHT AVAILABILITY, ORGANIC LOADING RATE, AND SOLIDS RESIDENCE TIME FOR VARIOUS TREATMENT OBJECTIVES INCLUDING NITROGEN OXIDATION AND REMOVAL EFFICIENCY. THE BASIC CONDITION FOR USING ACTIVATED ALGAE AS A SECONDARY-TERTIARY TREATMENT PROCESS IS ESTABLISHMENT OF A SYMBIOTIC RELATIONSHIP BETWEEN ALGAE AND AEROBIC BACTERIA. IN THIS STUDY IT WAS FOUND THAT, UNDER HIGH RATE CONDITIONS, NITROGEN LEVELS WERE CONTROLLED BY AUTOTROPHIC OXIDATION, AND PHOTOSYNTHETIC AND HETEROTROPHIC ASSIMILATION KINETICS. CONCLUSIONS WERE THAT: (1) LIGHT AVAILABILITY CONTROLS ALGAL GROWTH AND LIMITED ORGANIC LOAD FOR EFFECTIVE OPERATION; ACTIVATED ALGAE APPARENTLY MUST BE GROWN IN A SHALLOW SYSTEM WITH DAYLIGHT CONTROLLING BASIC REACTIONS. MAXIMUM GROWTH OCCURRED AT 43 CM WITH A COD LOADING RATE OF 1600-1900 MG/L/DAY. (2) NITROGEN REMOVAL RATES FOR SYNTHESIS, RANGING FROM 0.34-0.112 G N/G VSS, APPEARED TO BE LIMITED TO ASSIMILATIVE REQUIREMENTS. ORGANIC NITROGEN OF THE MIXED LIQUOR SOLIDS AVERAGED 13.3%. (3) THE GROWTH RATE OF ACTIVATED ALGAE MICROBES AND AUTOTROPHIC NITRIFERS BECAME LIMITED AT SRT VALUES OF ONE AND TWO DAYS RESPECTIVELY. (4) NITRIFICATION DECREASED ALKALINITY AT 7.1 G AS CACO3 MG/L OF AMMONIA NITROGEN METABOLIZED. (LYNCH-WISCONSIN)

DEMONSTRATING THE EFFECTS OF NUTRIENTS IN BIO-OXIDATION POND RECEIVING STREAMS.
REID, GEORGE W.; STREEBIN, LEALE E., AND; JR. OLIVER T. LOVE
OKLAHOMA UNIV., NORMAN. BUREAU OF WATER RESOURCES RESEARCH.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE AS PB-199 269, $3.00 IN PAPER COPY, $0.95 IN MICROFICHE. MAR 1971. 72 P, 16 FIG, 10 TAB, 49 REF, APPEND. ENVIRONMENTAL PROTECTION AGENCY PROGRAM 16010--03/71, DEMONSTRATION GRANT WPD-98-01-66.
05C;05D
THIS STUDY CONSIDERED THE RECEIVING STREAM AS AN INTEGRAL PART OF THE BIO-OXIDATION POND METHOD OF TREATMENT WITH THE OBJECTIVE BEING TO PROVIDE A BETTER UNDERSTANDING OF THE BIO-OXIDATION POND - RECEIVING STREAM SYSTEM. AS REPRESENTATIVE OF THIS 'REAL WORLD' SITUATION WITH ALL OF ITS VARIABLES, FIVE EXISTING CENTRAL OKLAHOMA BIO-OXIDATION PONDS WHICH HAD DIVERSE LOADINGS AND DESIGNS WERE UTILIZED. BY OBSERVING THESE SYSTEMS UNDER VARYING CLIMATIC CONDITIONS, THE EFFECTS OF THE BIO-OXIDATION POND NUTRIENTS ALONG WITH OTHER POLLUTIONAL PARAMETERS WHICH WERE DISCHARGED INTO INTERMITTENT RECEIVING STREAMS WERE EVALUATED. EXCEPT FOR SCOURING, BIO-OXIDATION PONDS AND BIO-OXIDATION POND RECEIVING STREAMS WERE FOUND TO BEHAVE ESSENTIALLY THE SAME AS THE STREAMS BECAME A CONTINUATION OF THE POND. IN ADDITION TO MAKING BIOCHEMICAL ADJUSTMENTS, THE STREAMS LOST MUCH OF THEIR BIOLOGICAL IDENTITY AND ASSUMED CHARACTERISTICS MORE CLOSELY ASSOCIATED WITH THE BIOLOGICAL LOADINGS FROM THE POND EFFLUENT. THE MOST PERSISTENT ALGAE IN THE SYSTEMS WERE THE FLAGELLATES (EUGLENOPHYTA) AND THE BLUE-GREEN ALGAE (CYANOPHYTA) AS THESE PLANKTERS HAD LITTLE DIFFICULTY MAKING THE TRANSITION FROM THEIR ACCLIMATED LIFE IN THE POND TO THE STREAM.

IN-PLANT WASTE ABATEMENT.
REITER, W. M.; STOCKER, W. F.
ALLIED CHEMICAL CORP., MORRISTOWN, N.J.
CHEMICAL ENGINEERING PROGRESS, VOL. 70, NO. 1, P 55-59, JANUARY, 1974. 7 FIG, 1 TAB.
ALUM, PHOSPHORIC ACID, HYDROFLUORIC ACID, ZERO DISCHARGE.
05D;03E
ALLIED CHEMICAL HAS ELIMINATED WASTE DISCHARGES FROM AN ALUM PLANT, AND IS CURRENTLY EVALUATING TECHNIQUES FOR ACHIEVING ZERO DISCHARGE FROM ITS PHOSPHORIC ACID AND HYDROFLUORIC ACID FACILITIES. TO REDUCE DISCHARGE INTO THE MISSISSIPPI RIVER NEAR NEW ORLEANS, A TWO-POND CONTAINMENT SYSTEM WAS INSTALLED, PUMPING WASTES TO THE FIRST LAGOON WHERE SUSPENDED SOLIDS ARE REMOVED, THEN TO THE SECOND WHICH FUNCTIONS AS A CLEAR WELL. THE WATER GOES BACK INTO THE PROCESS AS MAKE-UP FOR SUBSEQUENT BATCHES, COMPLETING A CLOSED-LOOP OPERATION. A RECYCLING METHOD FOR TRANSPORT WATER USED IN HF MANUFACTURE INVOLVES NEUTRALIZATION OF SLURRY AND SCRUBBER EFFLUENT; ANOTHER TREATMENT METHOD BEING USED IN HF MANUFACTURE IS DRY HANDLING OF THE HF FURNACE RESIDUE WITH CONCOMITANT ELIMINATION OF AQUEOUS WASTE. IN THE MANUFACTURE OF PHOSPHORIC ACID FOR FERTILIZER APPLICATIONS, ACIDULATION OF TRICALCIUM PHOSPHATE IS THE MAIN REACTION. ACID WATER EFFLUENT FROM THE PROCESS MAY BE RECYCLED WITH A 96% EFFECTIVENESS. (SANDOSKI-FIRL)

BIOMASS DISTRIBUTION AND KINETICS OF BAFFLED LAGOONS.
REYNOLDS, J. H.; NIELSON, S. B.; MIDDLEBROOKS, E. J.
UTAH STATE UNIV., LOGAN.
JOURNAL OF THE ENVIRONMENTAL ENGINEERING DIVISION PROCEEDINGS OF ASCE, VOL. 101, NO. EE6, P 1005-1024, DECEMBER, 1975, 6 FIG, 9 TAB, 25 REF.
*BIOMASS DISTRIBUTIONS, BAFFLED WASTE STABILIZATION PONDS.
05D
PERFORMANCE, BIOLOGICAL RESPONSES, AND KINETICS OF THREE BAFFLED MODEL WASTE STABILIZATION PONDS WERE COMPARED TO THOSE OF AN UNBAFFLED MODEL WASTE STABILIZATION POND TO DETERMINE THE EFFECTS OF BAFFLE CONFIGURATIONS AND INCREASING SUBMERGED SURFACE AREA. THREE KINETIC MODELS WERE DEVELOPED: A FIRST-ORDER COMPLETELY MIXED FLOW MODEL, A MODEL WITH MATERIALS BALANCES AND COMPLETELY MIXED FLOW, AND A FIRST-ORDER GROWTH MODEL WITH A PLUG-FLOW REACTOR CONFIGURATION. THE SUBMERGED SURFACE AREAS OF THE BAFFLED PONDS WERE EQUAL AND THE ENVIRONMENTAL FACTORS AFFECTING POND PERFORMANCE WERE IDENTICAL FOR ALL PONDS. THE PONDS WERE ILLUMINATED WITH FLUORESCENT LIGHTS AND FED A SYNTHETIC WASTE. PERFORMANCE AND BIOLOGICAL RESPONSES WERE MONITORED DURING SEVERAL DIFFERENT DETENTION TIMES. RESULTS OF MONITORING AND ANALYSES OF THE PONDS' VARIOUS ELEMENTS ARE GIVEN IN TABLES AND GRAPHS. A DENSE LAYER OF SCUM ON THE SURFACE OF THE MODEL POND LIQUID APPARENTLY INCREASES ODOROUS GASES EMITTED FROM THE POND, DECREASES THE KINETIC RATE OF BIODEGRADATION, DECREASES THE PH, AND DECREASES THE AMOUNT OF SUSPENDED SOLIDS. AT A DETENTION TIME OF 15 DAYS THERE WAS LITTLE DIFFERENCE AMONG THE POND CONFIGURATIONS IN THE AMOUNT OF ORGANIC CARBON REMOVAL, BUT AT A DETENTION TIME OF 1.5 DAYS THE DIFFERENCE WAS BETWEEN 53% AND 70%. BIOLOGICAL DEGRADATION RATES WERE SIGNIFICANTLY HIGHER IN THE BAFFLED PONDS THAN IN THE CONTROL POND, WITH THE LONGITUDINAL BAFFLE CONFIGURATION PROVIDING THE HIGHEST RATE OF REDUCTION OF SOLUBLE ORGANIC CARBON CONCENTRATIONS. (LOUSTAU-FINL)

INTERMITTENT SAND FILTRATION TO UPGRADE LAGOON EFFLUENTS--PRELIMINARY REPORT.
REYNOLDS, J. H.; HARRIS, S. E.; HILL, D.; FILIP, D. S.; MIDDLEBROOKS, E. J.
UTAH WATER RESEARCH LAB., LOGAN.
IN: UPGRADING WASTEWATER STABILIZATION PONDS TO MEET NEW DISCHARGE STANDARDS, AUGUST 21-23, 1974, LOGAN, UTAH, UTAH STATE UNIVERSITY, P 71-88, 15 FIG, 6 TAB, 9 REF.
*INTERMITTENT SAND FILTERS, HYDRAULIC LOADING RATES, *SAND FILTRATION.
05D
INTERMITTENT SAND FILTRATION CAN BE USED IN COMMUNITIES SURROUNDED BY LARGE AREAS OF OPEN LAND. THE PERFORMANCE OF THE FILTERS IN FULL-SCALE TESTS WERE EVALUATED AND COMPARED TO RESULTS OBTAINED USING LABORATORY AND PILOT SCALE FIELD INTERMITTENT SAND FILTERS. THE ULTIMATE OBJECTIVE WAS TO DEVELOP DESIGN CRITERIA THAT WILL CONSISTENTLY PRODUCE AN EFFLUENT THAT WOULD MEET STRINGENT WATER QUALITY STANDARDS. SAND WITH AN EFFECTIVE SIZE OF 0.17 MM WAS TESTED IN SIX FILTERS. HYDRAULIC LOADING RATES OF 0.2, 0.4, 0.6, 0.8, 1.0, AND 1.2 MGAD WERE USED. SAMPLES WERE COLLECTED AND ANALYZED FOR SUSPENDED SOLIDS, BIOCHEMICAL OXYGEN DEMAND, CHEMICAL OXYGEN DEMAND, TOTAL PHOSPHORUS, ORTHOPHOSPHORUS AMMONIA, NITRITE, PH, TEMPERATURE AND DISSOLVED OXYGEN. DIFFERENT TYPES OF ALGAE WERE USED IN THIS EXPERIMENT FROM LABORATORY AND PILOT SCALE TESTS, BUT THIS HAD LITTLE EFFECT ON THE FILTER PERFORMANCE. RESULTS SHOW THAT THE LENGTH OF THE FILTER RUNS DEPENDED ON THE ALGAL CONCENTRATION AND THE HYDRAULIC LOADING RATES. THE FILTER RUN WAS SHORTER IN THIS TEST THAN IN THE LABORATORY AND PILOT SCALE TESTS. IT VARIED FROM 14 DAYS WITH A HYDRAULIC LOADING RATE OF 1.2 MGAD TO 42 DAYS WITH A HYDRAULIC LOADING RATE OF 0.4 MGAD. TWICE AS MUCH OF THE TOTAL SUSPENDED SOLID MATTER WAS REMOVED BY FILTERS WITH A HYDRAULIC LOADING RATE OF 0.6 MGAD THAN WITH A LOADING RATE OF 1.2 MGAD. SUSPENDED SOLIDS WERE REDUCED TO LESS THAN 7.2 MG/LITER FROM AN AVERAGE OF 26.1 MG/LITER AND VOLATILE SUSPENDED SOLIDS WERE REDUCED TO LESS THAN 1.5 MG/LITER FROM AN AVERAGE OF 16.9 MG/LITER FOR ALL FILTERS. THESE FULL SCALE TESTS ESSENTIALLY CONFIRMED THE PREVIOUS LABORATORY AND PILOT SCALE STUDIES.

INTERMITTENT SAND FILTERS FOR UPGRADING LAGOON EFFLUENTS.
REYNOLDS, J. H.; HARRIS, S. E.; HILL, D.; FILIP, D. S.; MIDDLEBROOKS, E. J.
UTAH WATER RESEARCH LAB, LOGAN.
PUBLIC WORKS, VOL 106, NO 9, P 91-94, SEPTEMBER, 1975, 1 FIG, 2 TAB, 5 REF.
*INTERMITTENT SAND FILTERS, HYDRAULIC LOADING RATE.
05D
AN EXPERIMENTAL FULL-SCALE PLANT WAS BUILT AT THE LAGOON TREATMENT PLANT OF THE CITY OF LOGAN, OHIO, TO TEST THE EFFECTIVENESS OF INTERMITTENT SAND FILTERS FOR POLISHING LAGOON EFFLUENTS. THE FACILITY CONSISTED OF SIX FILTERS, EACH 25 BY 36 FEET AND CONTAINING THREE FEET OF PIT-RUN CONCRETE SAND WITH AN EFFECTIVE SIZE OF 0.17 MM AND UNIFORMITY COEFFICIENT OF 9.7. DATA WERE COLLECTED AND ANALYZED FOR HYDRAULIC LOADING RATES RANGING FROM 0.2 MGAD TO 1.2 MGAD. T ALGA GENERA PRESENT IN THE LAGOON EFFLUENT HAD LITTLE EFFECT ON THE PERFORMANCE OF THE INTERMITTENT SAND FILTERS. THE LENGTH OF THE FILTER RUN WAS

DIRECTLY RELATED TO THE INFLUENT ALGAL CONCENTRATION AND HYDRAULIC LOADING RATE. THE EFFLUENT TOTAL SUSPENDED SOLIDS CONCENTRATION INCREASED SLIGHTLY WITH AN INCREASE IN THE HYDRAULIC LOADING RATE. WHEN THE AVERAGE INFLUENT VOLATILE SUSPENDED SOLIDS (VSS) CONCENTRATION WAS 16.9 MG/LITER, THE FILTERS PRODUCED AN EFFLUENT WITH LESS THAN 1.5 MG/LITER OF VSS. THE INTERMITTENT SAND FILTER PRODUCED A CONSISTENT EFFLUENT BOD OF LESS THAN 5 MG/LITER AND FILTERED EFFLUENT BOD AND COD INCREASE SLIGHTLY WITH AN INCREASE IN THE HYDRAULIC LOADING RATE. THE INFLUENT AMMONIA-NITROGEN CONCENTRATION WERE REDUCED FROM 2.5 MG/LITER TO LESS THAN 0.54 MG/LITER. THE PH VALUES OF FILTER EFFLUENT WERE APPROXIMATELY 8.0 BUT RANGED BETWEEN 7.9 AND 8.9. THE FULL-SCALE FILTER TESTS ESSENTIALLY DUPLICATED THE PERFORMANCE OF LABORATORY AND PILOT SCALE TESTS. (ORR-FIRL)

BOD5 REMOVAL FROM AERATED LAGOON SYSTEMS.
RICH, L. G.; WHITE, S. C.
CLEMSON UNIV., S. C. DEPT. OF ENVIRONMENTAL SYSTEMS ENGINEERING.
WATER AND SEWAGE WORKS, REFERENCE ISSUE, P 21-23, APRIL, 1977. 6 FIG, 7 REF.
*BOD REMOVAL.
05D
DESIGN AND OPERATION CRITERIA WERE SUGGESTED FOR BOD REMOVAL IN AERATED LAGOON SYSTEMS. A FOUR-CELL, DUAL-POWER SYSTEM COULD ACHIEVE EFFLUENT QUALITY WITH A LOWER RETENTION TIME THAN A TWO-CELL, DUAL-POWER LEVEL SYSTEM. LAGOONS PRESENTLY USED ARE OF TWO TYPES. COMPLETELY SUSPENDED LAGOONS MAINTAIN ALL SETTEABLE SOLIDS IN SUSPENSION. PARTIALLY SUSPENDED SYSTEMS HOLD ONLY A PORTION OF SETTEABLE SOLIDS IN SUSPENSION. POWER LEVELS DEPEND UPON LAGOON GEOMETRY AND SIZE, AS WELL AS THE TYPE OF AERATOR INVOLVED. A COMPLETELY SUSPENDED CELL FOLLOWED BY A PARTIALLY SUSPENDED CELL USES LESS LAGOON VOLUME TO ATTAIN A DESIRED SOLUBLE BOD5 EFFLUENT CONCENTRATION THAN EITHER TYPE USED INDIVIDUALLY. VARIOUS EQUATIONS WERE USED TO DETERMINE TOTAL RETENTION TIMES FOR BOTH SYSTEMS. AN INFINITE RETENTION TIME WAS CALCULATED FOR BOTH SYSTEMS, BUT THE FOUR-CELL SYSTEM PRODUCED SHORTER RETENTION TIMES. THIS SYSTEM WOULD NOT PRODUCE ANY SIGNIFICANT ALGAL GROWTH WITH RETENTION TIMES UNDER 2 OR 3 DAYS. ALGAL GROWTH AT ANY RETENTION TIME WOULD BE GREATLY REDUCED BY THE SYSTEM. IT WAS FOUND THAT THE SYSTEM SHOWED GREATEST ENHANCEMENT WHEN THE CELL NUMBER WAS INCREASED FROM ONE TO THREE. MULTICELLULAR CONSTRUCTION RESULTED IN MUCH SMALLER CELLS. FLOW VARIATIONS COULD CREATE SOME SYSTEM INSTABILITY. THE DYNAMIC BEHAVIOR OF THE TWO SYSTEMS WAS STUDIED, AT VARIOUS FLOWS, WITH THE AID OF A MODELING PROGRAM. THE FOUR-CELL SYSTEM WAS SLIGHTLY MORE SENSITIVE TO FLOW VARIATIONS, BUT RECOVERY TIME COULD BE TWICE AS LONG. THIS SYSTEM'S SURFACE-OVERFLOW RATE IN THE LAST CELL WOULD HELP TO MAINTAIN A STABILITY IN ITS EFFLUENT SUSPENDED SOLIDS. RESULTS OF THE MODEL STUDY AND LABORATORY STUDIES PRODUCED SEVERAL DESIGN CRITERIA WHICH RELATED SETTLING CHARACTERISTICS OF BIOMASS SOLIDS, HYDRAULIC RETENTION TIMES, AND FLOW RATES TO BOD REMOVAL. (COLLINS-FIRL)

HOW TO DESIGN AERATED LAGOON SYSTEMS TO MEET 1977 EFFLUENT STANDARDS - EVALUATION OF KINETIC COEFFICIENTS.
RICH, L. G.; WHITE, S. C.
CLEMSON UNIV., S.C. DEPT. OF ENVIRONMENTAL SYSTEMS ENGINEERING.
WATER AND SEWAGE WORKS, VOL. 123, NO. 6, P 90-92, JUNE, 1976. 5 FIG.
5D;5G
LABORATORY TECHNIQUES AND MATHEMATICAL METHODS FOR ESTIMATING KINETIC COEFFICIENTS ASSOCIATED WITH THE DESIGN OF AERATED LAGOON SYSTEMS ARE DESCRIBED. RETENTION TIME AND POWER INPUT ARE CITED AS THE TWO MAIN FEATURES OF LAGOON DESIGN. THE SELECTION OF THE FORMER IS BASED ON A KNOWLEDGE OF WHICH RETENTION TIME PROVIDES THE BEST SOLIDS REMOVAL WITH SEDIMENTATION FOR A PARTICULAR WASTE AND ON THE RATE OF SOLUBLE ORGANIC REMOVAL. THE SELECTION OF POWER INPUT IS BASED ON THE AMOUNT OF OXYGEN NEEDED FOR RESPIRATION AND BIOLOGICAL CONVERSION OF THE WASTE WATER AND ON THE MIXING REQUIREMENTS. LABORATORY EQUIPMENT AND CALCULATION PROCEDURES ARE ILLUSTRATED FOR ESTIMATING CHANGES IN RESPIRATION RATES AND SOLUBLE BIOCHEMICAL OXYGEN DEMAND, DISSOLVED OXYGEN DEPLETION RATES, SUBSTRATE REMOVAL RATES, AND RESPIRATION COEFFICIENTS.

SOLIDS CONTROL IN EFFLUENTS FROM AERATED LAGOON SYSTEMS
RICH, L. G.
CLEMSON UNIV., SC. WATER RESOURCES RESEARCH INST.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-294 542, IN PAPER COPY, IN MICROFICHE. REPORT NO 73, 1978. 105 P, 28 FIG, 21 TAB, 34 REF, 2 APPEND. OWRT B-105-SC(1)

FIELD 05D

IN SOUTH CAROLINA, AS WELL AS IN OTHER STATES IN THE SOUTHEAST, WIDE USE HAS BEEN MADE OF AERATED LAGOON SYSTEMS TO TREAT MUNICIPAL WASTEWATER DISCHARGES OF LESS THAN ONE MILLION GALLONS PER DAY. THESE SYSTEMS FALL IN THE CATEGORY OF LOW-COST, LOW-ENERGY, AND LOW-MAINTENANCE TREATMENT TECHNOLOGY WHICH IS IDEAL FOR SUCH APPLICATION. UNFORTUNATELY, HOWEVER, THE PERFORMANCE OF EXISTING AERATED LAGOON SYSTEMS FAILS TO MEET THE REQUIREMENTS OF THE 1977 EFFLUENT STANDARDS ON A CONSISTENT BASIS. THE FAILURE CENTERS PRIMARILY ON THE SUSPENDED SOLIDS DISCHARGED FROM THE LAGOON AND THE BIOCHEMICAL OXYGEN DEMAND EXERTED BY THE SOLIDS. THIS REPORT DESCRIBES (1) A FIELD INVESTIGATION TO PROVIDE A MORE DEFINITIVE KNOWLEDGE OF THE PERFORMANCE OF EXISTING AERATED LAGOON SYSTEMS SERVING MUNICIPALITIES IN THE PIEDMONT REGION OF SOUTH CAROLINA, (2) A LABORATORY INVESTIGATION TO OBTAIN A BETTER UNDERSTANDING OF THE SETTLING CHARACTERISTICS OF BACTERIAL BIOMASS SOLIDS IN SUSPENSIONS WITH CONCENTRATIONS SIMILAR TO THOSE ENCOUNTERED IN AERATED LAGOON EFFLUENTS, AND (3) AN ENGINEERING STUDY TO DEVELOP CRITERIA FOR THE DESIGN OF AERATED LAGOON SYSTEMS CAPABLE OF IMPROVED PERFORMANCE WITH RESPECT TO EFFLUENT SUSPENDED SOLIDS. THE ENGINEERING STUDY INVOLVED THE ANALYSIS OF DATA OBTAINED FROM THE FIELD AND LABORATORY INVESTIGATIONS, AS WELL AS INFORMATION DERIVED FROM THE LITERATURE.

MATHEMATICAL SIMULATION OF WASTE STABILIZATION PONDS.
ROESLER, JOSEPH F.; PRICE, HERBERT C.
FEDERAL WATER QUALITY ADMINISTRATION, CINCINNATI, OHIO. ADVANCED WASTE TREATMENT LABS.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 180-185. 20 REF.
050
THE MASS BALANCE APPROACH WAS USED TO OBTAIN EQUATIONS RELATING TO OXIDATION LAGOON PROCESSES. THE MODEL WAS BASED ON THE ASSUMPTION THAT THE INFLUENT WAS DOMESTIC SEWAGE, AND THAT AN ANAEROBIC SLUDGE LAYER WAS FORMED AT THE BOTTOM OF THE POND. EQUATIONS WERE DERIVED FOR BOD REMOVAL BY ALGAE, ANAEROBIC DECOMPOSITION, AND OXIDATION POND DEPTH. IN ORDER TO VERIFY EQUATIONS DERIVED FROM THE MASS BALANCE APPROACH, EXPERIMENTAL DATA ON EFFLUENT BOD, DETENTION TIME, SUNLIGHT INTENSITY, TEMPERATURE, EVAPORATION RATE, AND DISSOLVED OXYGEN DEFICIENCY WERE OBTAINED FROM THE LITERATURE. A COMPUTER PROGRAM WAS THEN DESIGNED TO EVALUATE THE CONSTANTS AND THE DISPOSITION OF ALL BOD'S FROM THE PRECEDING EQUATION AND CALCULATIONS. IT WAS CONCLUDED THAT: (1) OXIDATION LAGOONS ARE ECONOMICAL TO BUILD AND MAINTAIN, (2) THE ROLE OF ALGAE HAS BEEN OVEREMPHASIZED, WITH RE-AERATION AND ANAEROBIC PROCESSES EQUALLY, IF NOT MORE, IMPORTANT, AND (3) SINCE ALGAE OCCASIONALLY INTERFERE WITH RECEIVING STREAM WATER QUALITY, INVESTIGATIONS SHOULD BE CONDUCTED IN HOW TO MAXIMIZE ANAEROBIC DECOMPOSITION AT THE BOTTOM AND MINIMIZE ALGAE PRODUCTION.

TREATMENT OF PACKINGHOUSE WASTEWATER BY SAND FILTRATION.
ROWE, M. L.
EAST CENTRAL OKLAHOMA STATE UNIV., ADA. SCHOOL OF ENVIRONMENTAL SCIENCE.
IN: PROCEEDINGS SEVENTH NATIONAL SYMPOSIUM ON FOOD PROCESSING WASTES, APRIL 7-9, 1976. 1976, P 356-366. 4 FIG, 7 TAB. TECHNICAL REPORT EPA-600/2-76-304.
030
INTERMITTENT SAND FILTER TREATMENT FOR PACKING HOUSE WASTE WATER WAS EVALUATED IN PILOT STUDIES AT THE W. E. REEVES PACKING COMPANY IN ADA, OKLAHOMA. TWO PILOT-SCALE FILTER UNITS WERE CONSTRUCTED ADJACENT TO THE EXISTING EXTENDED AERATION AND SECONDARY STAGE LAGOONS. THE FILTER UNITS RECEIVED WASTE WATER FROM THE LAGOON SYSTEM AT A RATE OF EQUIVALENT TO 0.5 MILLION GAL PER ACRE PER DAY. THE UNITS WERE FILLED WITH 18 INCHES OF GRAVEL RANGING FROM 1.25 INCHES IN DIAMETER AT THE BOTTOM OF THE FILTER TO 0.25 INCHES AT THE TOP, AND WERE COVERED WITH 36 INCHES OF SAND AT A DIAMETER OF 0.2 MM. THE UNITS WERE CONSTRUCTED WITH CLAY EMBANKMENTS WITH A 2.5:1 SLOPE ON THREE SIDES AND A COMMON CONCRETE WALL SEPARATING THE TWO UNITS ON THE FOURTH SIDE. EACH FILTER WAS EQUIPPED WITH A UNDERDRAIN NETWORK OF 5 INCHES DIAMETER PERFORATED PIPES. CONSTRUCTION COSTS FOR THE UNIT WERE $12,050. CLOGGING AFTER ONLY 2 DAYS OF OPERATION OF THE FILTER UNITS WAS ATTRIBUTED TO SLUDGE ACCUMULATIONS PRODUCED BY LOADING RATES IN EXCESS OF THE FILTER CAPACITY. AFTER CLEANING TO REMOVE THE 16,000 GAL OF SLUDGE ACCUMULATED IN THE BOTTOM, THE FILTERS WERE AGAIN PUT INTO OPERATION AND CLOGGED WITHIN 4 DAYS. FURTHER INVESTIGATIONS REVEALED THAT AERATION IN THE LAGOON SYSTEM DURING THE 4-HR LOADING PERIOD INCREASED THE AMOUNT OF SLUDGE LOADED ONTO THE FILTERS. AFTER CORRECTION OF PROBLEMS CAUSED BY AERATOR TIMING, THE SETTLING TIME IN THE LAGOON WAS INCREASED AND THE FILTERS PERFORMED PROPERLY WITH AVERAGE BOD AND SUSPENDED SOLIDS VALUES IN THE EFFLUENTS OF 8 AND 12 MG/LITER, RESPECTIVELY. (SCHULZ-FIRL)

UPGRADING OF SEWAGE LAGOON EFFLUENTS.
RUPKE, J. W. G.; CHISHOLM, K.
ONTARIO MINISTRY OF THE ENVIRONMENT, TORONTO. POLLUTION CONTROL BRANCH.
CANADA-ONTARIO AGREEMENT ON THE GREAT LAKES WATER QUALITY, RESEARCH REPORT NO. 54, ENVIRONMENTAL PROTECTION SERVICE, FISHERIES AND ENVIRONMENT CANADA, OTTAWA, CANADA, 1977. 27 P, 11 FIG, 4 TAB.
74-1-37.
*STRATHROY(ONTARIO).
05D;05G
VARIOUS UNIT PROCESSES WERE EVALUATED AT THE STRATHROY, ONTARIO, LAGOON FOR THE PURPOSE OF UPGRADING CONVENTIONAL LAGOON EFFLUENT QUALITY. SYSTEMS TO REDUCE BOTH THE SUSPENDED MATTER AND ALSO THE SOLUBLE COMPONENTS WERE USED. UNIT PROCESSES INVESTIGATED INCLUDED PHYSICAL-CHEMICAL TREATMENT FOLLOWED BY FILTRATION, AIR FLOTATION, MICROSTRAINING AND THE ROTATING BIOLOGICAL CONTACTOR. IT WAS FOUND THAT A SUITABLE SYSTEM FOR UPGRADING LAGOON EFFLUENT QUALITY WOULD INVOLVE A ROTATING BIOLOGICAL CONTACTOR FOR AMMONIA NITROGEN AND SOLUBLE BOD REDUCTION, FOLLOWED BY CHEMICAL COAGULATION-SEDIMENTATION AND MULTIMEDIA FILTRATION. (WATDOC)

LAGOON PERFORMANCE AND THE STATE OF LAGOON TECHNOLOGY.
RYCKMAN, EDGERLEY, TOMLINSON AND ASSOCIATES, INC., ST. LOUIS, MO.
COPY AVAILABLE FROM GPO SUP DOC AS EP1.23/2:73-144, $2.60; MICROFICHE FROM NTIS AS PB-223 129, $1.45.
ENVIRONMENTAL PROTECTION AGENCY TECHNOLOGY SERIES REPORT EPA-R2-73-144, JUNE 1973. 214 P, 23 FIG, 10 TAB, 60 REF. EPA PROJECT 17090 FDD, 14-12-892, 68-01-0014.
LAGOONING, *LAGOON TREATMENT.
05D;10F
THE PHENOMENAL GROWTH OF OXIDATION LAGOONS AS A FORM OF MUNICIPAL WASTE TREATMENT IS A REFLECTION OF THEIR RELATIVELY LOW COST AND EASE OF MAINTENANCE. THE WIDESPREAD ACCEPTANCE OF LAGOONING WAS ORIGINALLY PREDICATED ON THEIR ABILITY TO PRODUCE EFFLUENT QUALITY AT LEAST EQUIVALENT TO ACCEPTED SECONDARY TREATMENT. IN THE SEMI-ARID GREAT PLAINS STATES WHERE LAGOONS WERE ORIGINALLY SUCCESSFUL, SUCH EFFICIENCIES WERE EASILY ACHIEVED FOR MOST OF THE YEAR. UNFORTUNATELY, DIFFERENCES IN CLIMATE (ESPECIALLY SUNLIGHT AND RAINFALL), SOIL TYPE, POPULATION DENSITY AND A MULTITUDE OF DIVERSE PROBLEMS HAVE WORKED AGAINST SUCH SUCCESS FOR OTHER PORTIONS OF THE COUNTRY. INVENTORY AND OPERATIVE DATA FROM MUNICIPAL LAGOON FACILITIES HAVE BEEN COLLECTED AND EVALUATED. THE ADEQUACY OF SUCH FACILITIES TO PRODUCE EFFLUENT TO MEET STATE WATER QUALITY CRITERIA FOR RECEIVING WATERS HAS BEEN EVALUATED. (EPA)

LABORATORY STUDIES OF UPGRADING EFFLUENT WATER QUALITY FROM SEWAGE LAGOONS.
SANKS, R. L.
MONTANA STATE UNIVERSITY, BOZEMAN. DEPT. OF CIVIL ENGINEERING AND ENGINEERING MECHANICS.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-272 312, IN PAPER COPY, IN MICROFICHE. MONTANA UNIVERSITY JOINT WATER RESOURCES RESEARCH CENTER, BOZEMAN, RESEARCH REPORT NO. 84, MARCH 1977. 77 P, 8 FIG, 17 TAB, 70 REF. OWRT A-089-MONT(1), 14-34-0001-6027.
MICROSTRAINING.
05D
WATER FROM A MUNICIPAL SEWAGE LAGOON WAS TREATED IN THE LABORATORY BY FOUR PROCESSES: COAGULATION, ROCK FILTRATION, INTERMITTENT SAND FILTRATION AND RAPID SAND FILTRATION. ALL PROCESSES WERE CAPABLE OF PRODUCING EFFLUENT THAT WOULD NEARLY MEET (AND SOME WOULD EXCEED) THE REQUIREMENTS OF PUBLIC LAW 92-500. RAPID SAND FILTRATION WAS IMPRACTICAL DUE TO SHORT FILTER RUNS. AN EXTENSIVE LITERATURE SEARCH REVEALED THAT THE PROCESSES OF GREATEST PROMISE FOR EFFECTIVENESS, RELIABILITY, AND ECONOMY UNDER MONTANA CONDITIONS APPEAR TO BE: INTERMITTENT SAND FILTRATION, SEASONAL DISCHARGE AT SELECTED TIMES, AND INTEGRATED PONDING SYSTEMS WITH ENCLOSED CHAMBERS OR DEEP LAGOONS DESIGNED TO REMOVE ALGAE BY SEDIMENTATION. A REALISTIC FIELD RESEARCH PROGRAM IS NEEDED TO EVALUATE THE RELIABILITY AND ECONOMY OF THESE PROCESSES FOR UPGRADING MONTANA LAGOONS. (STUART-MONT STATE)

STUDIES ON SEPARATION OF ALGAE FROM STABILIZATION POND EFFLUENTS BY COAGULATION
SASTRY, C. A.; RAO, M. N.; RAO, A. V.
NATIONAL ENVIRONMENTAL ENGINEERING RESEARCH INST. (INDIA). ZONAL LAB.
JOURNAL OF THE INSTITUTION OF ENGINEERS (INDIA). VOL. 57, PART EN 3, P 91-94, JUNE, 1977. 6 TAB, 6 REF.
FIELD 05D
INDIA'S SUNNY CLIMATE AND THE ECONOMY OF THE PROCESS HAVE LED TO THE WIDESPREAD USE OF WASTE STABILIZATION PONDS AS A MEANS OF WASTE WATER TREATMENT IN INDIA. ALGAL CELL MATERIAL PRODUCED IN THE

PONDS IS SUGGESTED AS A SOURCE OF PROTEIN FOR ANIMAL FEED SUPPLEMENTS. COAGULATION OF ALGAE IN STABILIZATION POND EFFLUENTS WITH NIRMALI (STRYCHNOS POTATORUM) SEED EXTRACTS AND ALUM WAS INVESTIGATED WITH EFFLUENTS OBTAINED FROM THE SHAHPURA OXIDATION PONDS IN BHOPAL, INDIA. THE FOUR 201 X 50 X 1-M PONDS ARE EACH DIVIDED INTO TWO EQUAL PRIMARY AND SECONDARY UNITS AND ARE DESIGNED TO TREAT A TOTAL OF 3 MGD OF MUNICIPAL WASTES FROM BHOPAL. ALGAL SPECIES OBSERVED IN THE TEST EFFLUENTS ARE LISTED. IN STUDIES WITH ALUM DOSES OF 120-240 MG/LITER AND EFFLUENTS CONTAINING 250,000-267,000 ALGAE PER ML, 95-97% OF THE ALGAE WAS COAGULATED WITH AN ALUM DOSE OF 240 MG/LITER. IN STUDIES WITH FLOCCULATION TIMES OF 5-30 MIN, OPTIMUM ALGAE REMOVAL WAS OBTAINED WITH A FLOCCULATION TIME OF 20-25 MIN AND A SETTLING TIME OF 30 MIN. ALGAE REMOVAL WAS ALSO INVESTIGATED WITH POLYELECTROLYTES AT DOSES OF 0-10 MG/LITER USING MAGNIFLOC 990, SEPARAN NP 10, WISPROFLOC, AND NIRMALI SEED EXTRACT. WHILE NIRMALI SEED WAS MORE EFFECTIVE THAN THE OTHER AGENTS, POLYELECTROLYTES USED ALONE WERE NOT AS EFFECTIVE IN COAGULATING ALGAE AS THE ALUM. STUDIES ON THE USE OF NIRMALI SEED EXTRACT IN CONJUNCTION WITH ALUM INDICATED THAT 98-99% REMOVAL OF ALGAE COULD BE OBTAINED WITH AN ALUM DOSE OF 180 MG/LITER AND A NIRMALI SEED EXTRACT DOSE OF 8 MG/LITER. (SCHULZ-FIRL)

ANAEROBIC LAGOONS VERSUS AERATED LAGOONS IN THE TREATMENT OF PACKING-HOUSE WASTES.
SAUCIER, J. W.
TENNESSEE STATE DEPT. OF PUBLIC HEALTH, NASHVILLE.
PROCEEDINGS, INDUSTRIAL WASTE CONFERENCE, 24TH, MAY 6, 7, AND 8, 1969. P 534-541, 2 FIG, 3 TAB, 1 REF.
PACKING PLANTS, SUSPENDED SOLIDS, GREASE.
05D
TENNESSEE DOES NOT HAVE MANY LARGE MEAT-PACKING INDUSTRIES. MOST OF THIS TYPE PLANTS ARE SMALL OPERATIONS LOCATED IN RELATIVELY SMALL COMMUNITIES. IN MOST INSTANCES THE WASTES FROM THE MEAT-PACKING INDUSTRIES ARE TREATED IN COMBINATION WITH THE DOMESTIC WASTES. THE TYPICAL WASTES FROM ANIMAL SLAUGHTERING AND MEAT-PACKING OPERATIONS HAVE A VERY HIGH CONCENTRATION OF BOD, SUSPENDED SOLIDS AND GREASE. UNION CITY, TENNESSEE CONSTRUCTED AN ANAEROBIC LAGOON AS A PRE-TREATMENT PROCESS FOR THESE WASTES PRIOR TO RECEIPT AT ACTIVATED SLUDGE PLANT. THE LAGOON WAS DESIGNED TO HAVE A DEPTH OF 10.5 FEET AND A BOD LOADING OF 15 LB/1000 CU. FT. AFTER 3.5 YEARS OF OPERATION, BOD OF THE EFFLUENT AVERAGES 100 MG/1 OR LESS AND SUSPENDED SOLIDS 150 MG/1. COST FOR THE FACILITY IS $7/LB BOD REMOVED. HALLSDALE-POWELL UTILITY DISTRICT CONTRACTED WITH THE PURITY PACKING COMPANY TO TREAT THE COMPANY'S WASTES AND ELIMINATE WHAT HAD BEEN A BAD WATER POLLUTION PROBLEM. A TWO-CELL AREATED LAGOON WAS DESIGNED BASED ON AN INFLUENT OF 565 MG/1 BOD AND A FLOW OF 100,000 GPD. BECAUSE OF THE HIGH DEGREE OF TREATMENT REQUIRED AND UNCERTAINTY REGARDING THE AERATION EQUIPMENT, THE FACILITY WAS OVER DESIGNED. THE EFFLUENTS DISCHARGED TO THE RECEIVING STREAM AVERAGE LESS THAN 4 MG/1 BOD AND 7 MG/1 SUSPENDED SOLIDS. COSTS ARE $127/LB BOD REMOVED PER DAY. (GOESSLING-TEXAS)

HOW TO MEET WATER CLEANUP DEADLINES.
SCHMIDT, R. K.
ECODYNE CORP., UNION, N. J.
ENVIRONMENTAL SCIENCE AND TECHNOLOGY, VOL. 10, NO. 2, P. 140-143, FEBRUARY, 1976. 2 FIG, 2 ILLUS.
STEEL INDUSTRY.
5D;3F
PRIMARY, SECONDARY, AND TERTIARY WASTE WATER TREATMENT PROCESSES ARE DISCUSSED BRIEFLY WITH RESPECT TO OBJECTIVES AND EQUIPMENT. IN GENERAL, PROGRESSING FROM PRIMARY TO TERTIARY TREATMENT INVOLVES MORE COMPLEX APPLICATION TECHNOLOGY AND INVARIABLY HIGHER EXPENSE. BASIC EFFLUENT TREATMENT PROCESSES USED BY STEEL MILLS, PLATING MILLS, FOOD-PROCESSING PLANTS, AND PULP AND PAPER MILLS ARE ALSO DISCUSSED. THE WASTE WATER TREATMENT TECHNOLOGY PRESENTLY IN USE AT MOST PAPER MILLS INCLUDES PRIMARY CLARIFICATION FOR SUSPENDED SOLIDS REMOVAL, FOLLOWED BY BIOLOGICAL TREATMENT, WHICH FOR THE MOST PART CONSISTS OF STABILIZATION LAGOONS FOR BOD REMOVAL. THE 1977 ENVIRONMENTAL PROTECTION AGENCY STANDARDS REQUIRE PAPER MILLS TO FILTER THE EFFLUENT FROM THE PONDS TO REMOVE TRACE SUSPENDED SOLIDS BEFORE DISCHARGE. A PHYSICAL/CHEMICAL PROCESS (CHEMICAL ADDITION AND PRECIPITATION IN A CLARIFIER) IS BEING USED TO REMOVE COLOR FROM PAPER MILL EFFLUENTS. DIAGRAMS ARE INCLUDED ILLUSTRATING WASTE WATER TREATMENT PROCESSES AT A STEEL MILL, PULP AND PAPER MILL, AND FOOD PROCESSING PLANT. (WITT-IPC)

CALCULATED YIELD OF SEWAGE LAGOON BIOMASS, A PLAN FOR PRODUCTION, AND SOME OF THE PROBLEMS INHERENT IN USING BIOMASS OR LAGOON WATER FOR PRODUCTION OF FOOD AND FIBER.
SCHLAR, K.; GOLOMBEK, J. H.

BOWLING GREEN STATE UNIV., OHIO. DEPT. OF BIOLOGY.
IN: WASTEWATER USE IN THE PRODUCTION OF FOOD AND FIBER -- PROCEEDINGS, MARCH 5-7, 1974, OKLAHOMA CITY, OKLAHOMA, P 102-109, 18 REF.
METHANOL(METHYL ALCOHOL).
05D
LAGOON SEWAGE TREATMENT PRODUCES, IN ADDITION TO THE WATER, A HUGE VOLUME OF PLANT AND ANIMAL BIOMASS. A SINGLE CROP FOR THE TERMINAL AEROBIC LAGOON AT THE DESHLER, OHIO, WASTE WATER TREATMENT PLANT YIELDS 1596 CU M OF DRY BIOMASS PER HECTARE. REMOVAL OF THE FLOATING MATERIAL COULD INCREASE THE YIELD TO OVER 2000 CU M PER HECTARE. PROPOSED METHODS OF HARVESTING THE BIOMASS ARE GIVEN AND USES ARE SUGGESTED, INCLUDING AS A COMPONENT IN DOMESTIC ANIMAL FEEDS, TO GENERATE METHANOL, AND AS A SOIL CONDITIONER. PROBLEMS ASSOCIATED WITH THE USE OF THE BIOMASS MATERIAL, SUCH AS CONTAMINATION BY TOXIC SUBSTANCES OR PATHOGENIC BACTERIA, ARE DISCUSSED.

A COMPARISON OF AN EFFICIENT LAGOON SYSTEM WITH OTHER MEANS OF SEWAGE DISPOSAL IN SMALL TOWNS.
SCHURR, KARL
BOWLING GREEN STATE UNIV., OHIO.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 95-100, 8 FIG, 9 REF.
SUSPENDED SOLIDS.
05D
AN OXIDATION LAGOON AND A CONVENTIONAL PRIMARY-SECONDARY SEWAGE TREATMENT FACILITY WERE COMPARED WITH RESPECT TO PH, TURBIDITY, NITRATES, PHOSPHATES, NITRITES, CHLORIDE, CONDUCTIVITY, AND COLIFORM BACTERIA, BY COMPARING THE FINAL TANK OF THE LAGOON SYSTEM TO THE RECEIVING STREAM OF THE CONVENTIONAL SYSTEM. THE OXIDATION LAGOON WAS FOUND TO PROVIDE A SIGNIFICANTLY HIGHER DEGREE OF WASTE TREATMENT AT A LOWER COST. THE RESULTS OF THE LAGOON VERSUS CONVENTIONAL TREATMENT COMPARISON INDICATE THAT LAGOONS MAY BE OF SIGNIFICANT VALUE IN SMALLER TOWNS AND CITIES WHERE ECONOMY IS ESSENTIAL. IN MOST OF THE SMALLER TOWNS, LAND VALUES ARE WITHIN THE RANGE OF PRICE WHERE ECONOMICAL LAGOONS MAY BE BUILT. OTHER ATTRACTIVE FEATURES OF LAGOONS ARE THEIR LOW MAINTENANCE COSTS, AND LESSER LABOR REQUIREMENTS. MORE WORK IS NECESSARY TO IMPROVE THE EFFICIENCY OF LAGOONS, BUT THEY ARE ALREADY A PROMISING ALTERNATIVE TO AREAS WHICH NEED TREATMENT FACILITIES BUT CANNOT AFFORD CONVENTIONAL PLANTS.

DISTRIBUTION OF BLUE-GREEN ALGAL VIRUSES IN VARIOUS TYPES OF NATURAL WATERS.
SHANE, M. S.
DELAWARE UNIV., NEWARK, DEPT. OF BIOLOGICAL SCIENCES.
WATER RESEARCH, VOL 5, NO 9, P 711-716, SEPTEMBER 1971. 1 FIG, 3 TAB, 10 REF.
*LPP VIRUS, *BLUE-GREEN ALGAL VIRUSES, *PLECTONEMA BORYANUM, SUSQUEHANNA RIVER, BRANDYWINE RIVER, RED CLAY RIVER, WHITE CLAY RIVER, CHRISTINA RIVER, BIG ELK RIVER, LITTLE ELK RIVER, OCTORARA RIVER, PLECTONEMA, LYNGBYA, PHORMIDIUM, CYANOPHYCEAE, OSCILLATORIACEAE, SCHIZOTHRIX CALCICOLA, ELKTON POND, RISING SUN POND, INDUSTRIAL STORAGE TANKS.
05B;05C
A SURVEY WAS CONDUCTED IN THE DELAWARE-MARYLAND AREA TO ASCERTAIN THE DISTRIBUTION OF LPP BLUE-GREEN ALGAL VIRUSES IN ALL TYPES OF NATURAL WATERS. THEIR PRESENCE WAS DETERMINED ON THE BASIS OF THE ABILITY OF SAMPLES TO PRODUCE LYSIS IN CULTURES OF THE ALGAL TEST ORGANISM, PLECTONEMA BORYANUM (UI581), AND TO FORM PLAQUES ON THE HOST ALGAL LAWN USING THE SOFT-AGAR TECHNIQUE OF SAFFERMAN AND MORRIS. THE VIRAL CONCENTRATION WAS DETERMINED BY THE DIRECT COUNT OF THE NUMBER OF PLAQUES FORMED PER ML OF WATER SAMPLE. THE VIRAL STRAIN, LPP-1, WAS DETERMINED FOR SELECTED VIRAL CULTURES ISOLATED FROM THE CHRISTINA, RED CLAY, AND WHITE CLAY RIVERS AND THE ELKTON AND RISING SUN OXIDATION PONDS. LPP-VIRUSES EXISTED IN EVERY TYPE OF WATER. THE OXIDATION PONDS GAVE THE HIGHEST PERCENTAGE OF SAMPLES CONTAINING AT LEAST ONE VIRUS AND THE HIGHEST CONCENTRATION OF VIRUSES. ALL RESERVOIRS AND INDUSTRIAL STORAGE TANKS WHICH CONTAINED VIRUSES HAD INFLUENTS WHICH ALSO CONTAINED VIRUSES. TEST DATA ON THE RIVERS SHOWED THESE VIRUSES PRESENT IN MOST STREAMS. THE VIRUSES WERE CONSISTENTLY ABSENT FROM THE HEADWATERS OF THE THREE RIVERS LISTED ABOVE BUT INCREASED AS THESE RIVERS FLOWED THROUGH MORE POPULATED AREAS. THE HEADWATERS FOR ALL THREE ARE IN LOW POPULATION DENSITY AND RURAL ENVIRONMENTS. IT IS SUGGESTED THAT THE ALGAL HOSTS OF THESE VIRUSES THRIVE IN AREAS OF HIGH ORGANIC MATERIAL SUCH AS MAY BE ASSOCIATED WITH POLLUTION. TABLES SHOW THE DISTRIBUTION AND INCIDENCE OF THE LPP-VIRUSES IN THE WATERS.

TERTIARY PHOSPHORUS REMOVAL AND LIMITING NUTRIENT STUDIES AT C.F.S. LAC ST. DENIS.
SHANNON, E. E.; SALVO, J. M.

ENVIRONMENTAL PROTECTION SERVICE, BURLINGTON (ONTARIO). WASTEWATER TECHNOLOGY CENTRE.
ENVIRONMENT CANADA WATER POLLUTION CONTROL DIRECTORATE REPORT NO. EPS 4-WP-74-1. FEBRUARY 1974. 60 P. 16 FIG, 16 TAB, 24 REF.
ALUM, BACKWASH, *C.F.S. LAC ST. DENIS (CANADA).
05D
PILOT PLANT EXPERIMENTS ON THE TREATMENT OF THE STABILIZATION POND EFFLUENT FROM CANADIAN FORESTRY SERVICES LAC ST. DENIS ARE DESCRIBED. THE PLANT WAS A 10 IGPM CHEMICAL TREATMENT SYSTEM CONSISTING OF CHEMICAL COAGULATION, FLOCCULATION, TUBE SETTLING, AND MIXED MEDIA FILTRATION COMPONENTS. VARIOUS ALUM AND POLYMER FEED CONDITIONS WERE EVALUATED OVER THE 10 MO PERIOD OF CONTINUOUS OPERATION. ALGAL ASSAYS WERE CARRIED OUT ON THE RECEIVING WATER, LAC DEPATIE, TO DETERMINE THE LIMITING NUTRIENT AND TO ASCERTAIN THE EFFECT OF TREATED AND UNTREATED POND EFFLUENT UPON ALGAL GROWTH. BECAUSE OF SEASONAL VARIATIONS IN THE QUALITY OF THE STABILIZATION POND EFFLUENT, IT WAS OBSERVED THAT THE RECOMMENDED SUMMER ALUM DOSAGE LEVEL OF 100 MG/L MUST BE INCREASED TO 150 MG/L TO ACHIEVE EQUIVALENT PHOSPHORUS REMOVAL. FILTER BACKWASH REQUIREMENTS AND BACKWASH SLUDGE PRODUCTION AND CHARACTERISTICS WERE DETERMINED. FOR SEVERAL CHEMICAL FEED CONDITIONS THE PILOT PLANT DEMONSTRATED A LIMITED CAPABILITY FOR ZINC, LEAD, IRON, AND NITROGEN REMOVAL AND A HIGH EFFICIENCY FOR COLIFORM REMOVAL. PHOSPHORUS WAS THE PROBABLE LIMITING NUTRIENT IN LAC DEPATIE AND THE PLANNED EFFORTS TO REDUCE PHOSPHORUS LOADING TO THE LAKE FROM C.F.S. LAC ST. DENIS SHOULD SIGNIFICANTLY REDUCE THE PRESENT EUTROPHIC CONDITIONS. CHEMICAL OPERATING COSTS ARE ESTIMATED AT 5.3 CENTS/1000 I GAL. (MERRITT-FIRL)

APPARATUS FOR SEWAGE TREATMENT AND WASTEWATER RECLAMATION.
SHELEF, G.
HEBREW UNIV., JERUSALEM (ISRAEL); AND YISSUM RESEARCH DEVELOPMENT CO., JERUSALEM (ISRAEL). (ASSIGNEE
UNITED STATES PATENT 3,954,615. ISSUED MAY 4, 1976. OFFICIAL GAZETTE OF THE UNITED STATES PATENT OFFICE, VOL. 946, NO. 1, P 246, MAY, 1976. 1 FIG.
05D
AN IMPROVEMENT HAS BEEN PATENTED IN A SYSTEM TO TREAT WASTE WATER USING ALGAE. THE TECHNOLOGY CONSISTS OF A POND WHICH CONTAINS MEANS FOR CHANNELING THE WASTE WATER ALONG AN ENDLESS PATH AND MEANS TO AERATE AND MAINTAIN THE FLOW OF WASTE WATER. ACCORDING TO THE IMPROVEMENT, THE POND IS DEEPER BENEATH THE AERATION MEANS THAN THE PATH DEPTH IN THE REMAINING PARTS OF THE POND. THE GREATER DEPTH PROVIDES A SOLUBILITY GRADIENT WHICH INCREASES THE AMOUNT OF OXYGEN THAN CAN BE DISSOLVED INTO THE LIQUID BY THE AERATION MEANS. (SNYDER-FIRL)

PREDICTION OF PHOTOSYNTHETIC BIOMASS PRODUCTION IN ACCELERATED ALGAL-BACTERIAL WASTEWATER TREATMENT SYSTEMS.
SHELEF, G.; SCHWARZ, M.; SCHECHTER, H.
HEBREW UNIV., JERUSALEM (ISRAEL). DEPT. OF MEDICAL ECOLOGY.
PREPRINT, PRESENTED AT 6TH INTERNATIONAL WATER POLLUTION RESEARCH CONFERENCE, SESSION 5, HALL A, PAPER NO 5, JUNE 20, 1972. P A/5/9/1-A/5/9/10, 6 FIG, 2 TAB, 23 REF.
ALUM, FERRIC CHLORIDE, *JERUSALEM(ISRAEL).
05D
THE USE OF SPECIALLY DESIGNED PONDS AS A CONTROLLED WASTE WATER TREATMENT WITH MAXIMIZED PHOTOSYNTHETIC ACTIVITY OF ALGAE WAS DEMONSTRATED. THE KINETICS OF ALGAE PRODUCTION WITH RESPECT TO SOLAR INCIDENT IRRADIANCE SERVED FOR THE CONSTRUCTION OF A MATHEMATICAL MODEL FOR PREDICTING ALGAE BIOMASS PRODUCTION AND THE CONCENTRATION OF ALGAE AS A FUNCTION OF HYDRAULIC DILUTION RATE UNDER GIVEN LEVELS OF SOLAR IRRADIANCE. THE PREDICTED LEVELS OF ALGAE PRODUCTION AND CONCENTRATIONS WERE CLOSE TO ACTUAL LEVELS, ALTHOUGH IN DETERMINING THE OPTIMAL DILUTION RATE, SOME CORRECTIONS HAD TO BE MADE. THE REMOVAL EFFICIENCY OF ORGANIC MATTER AND NUTRIENTS IN THE POND SYSTEM WAS RELATIVELY HIGH, PROVIDED THE ALGAE BIOMASS WAS SEPARATED FROM THE EFFLUENT. A 1,750 GAL/HR RECTANGULAR FLOTATOR WAS USED FOR SEPARATING THE ALGAL BIOMASS FROM THE POND EFFLUENT AFTER TREATMENT WITH ALUM OR FERRIC CHLORIDE. PERFORMANCE DATA OF THE ACCELERATED PHOTOSYNTHETIC POND FOR MONTHS JUNE AND DECEMBER WERE ARRANGED IN TABULAR FORM.

NUTRIENTS AND ALGAL REMOVAL FROM OXIDATION PONDS EFFLUENTS.
SHINDALA, ADNAN

MISSISSIPPI STATE UNIV., STATE COLLEGE. DEPT. OF SANITARY ENGINEERING.
CONFERENCE HELD APRIL 13-14, 1971, VICKSBURG; WATER RESOURCES RESEARCH INSTITUTE, MISSISSIPPI STATE UNIVERSITY, P 1-7, 1971. 7 P, 1 FIG, 1 TAB, 3 REF.
NUTRIENT REMOVAL.
05G;05D
CHEMICAL COAGULATION IS AN EFFECTIVE POST TREATMENT PROCESS FOR ALGAL REMOVAL AND FOR IMPROVING THE QUALITY OF EFFLUENTS FROM STABILIZATION PONDS. OF THE COAGULANTS TESTED, ALUM WAS THE BEST. THE OPTIMUM DOSAGE FOR BEST REMOVAL OF THE PARAMETERS STUDIED WAS IN THE RANGE OF 75 TO 100 MG/LITER. USING THIS DOSAGE, THE SUPERNATANT FROM THE CHEMICAL COAGULATION PROCESS WAS FOUND TO CONTAIN 2.5 MG/LITER BOD, 22.5 MG/LITER COD, 1.5 MG/LITER TOTAL PHOSPHATES, 3.5 MG/LITER TOTAL PHOSPHATES, 3.5 MG/LITER TOTAL NITROGEN, 500 TO 1000 ALGAL CELLS/ML AND APPROXIMATELY 5,000 COLIFORMS/100 ML. THE ALGAE IN THE POND EFFLUENTS CONTRIBUTE HEAVILY TO THE BOD, COD, AND NITROGEN IN THE EFFLUENT, WHILE THE CONTRIBUTION TO THE PHOSPHATES CONCENTRATION WAS LESS IMPORTANT.

EVALLATION OF SOME STABILIZATION PONDS IN INDIA.
SIDDIQI, R. H.; HANDA, B. K.
CENTRAL PUBLIC HEALTH ENGINEERING RESEARCH INST., NAGPUR (INDIA).
JOURNAL OF THE SANITARY ENGINEERING DIVISION, AMERICAN SOCIETY OF CIVIL ENGINEERS, VOL 97, NO SA1, P 91-100, FEBRUARY 1971. 7 FIG, 1 TAB, 11 REF.
FACULTATIVE MICROORGANISMS, INDIA.
05D
CLIMATIC CONDITIONS IN INDIA ARE FAVORABLE TO THE OPERATION OF ENGINEERED WASTE STABILIZATION PONDS. CONSEQUENTLY, THE TREATMENT OF WASTES IN SUCH PONDS IS ECONOMICALLY COMPETITIVE WITH CONVENTIONAL BIOLOGICAL TREATMENT. DATA COLLECTED FROM SEVERAL INSTALLATIONS IN INDIA WERE ANALYZED TO DETERMINE WHAT USEFUL PARAMETERS OF OPERATION COULD BE IDENTIFIED. POND LOADING WAS FOUND TO BE BEST EXPRESSED BY A LOAD FACTOR, L SUB F, WHICH IS THE RATIO OF BOD LOAD TO ALGAL PRODUCED OXYGEN. FOR L SUB F BETWEEN .44 AND 8.0, THE PERFORMANCE WAS DETERMINED FROM THE FOLLOWING EQUATION: E = 100 OVER (1 + 0.188 L SUB F OR EXPLANENTIAL TO 0.48). FROM THE PRECEDING INVESTIGATIONS, IT WAS DETERMINED THAT THE MAJORITY OF ORGANIC MATTER DESTROYED IS DESTROYED ANAEROBICALLY. THEREFORE, PONDS OF DEPTH GREATER THAN 5 FEET ARE MORE EFFICIENT IN THEIR OPERATION SINCE THERE IS LESS TURBULENCE AND LESS CHANGE OF THE ANAERODES BEING EXPOSED TO OXYGEN. IT WAS ALSO DETERMINED THAT SINGLE CELL REACTORS, OR THE FIRST CELL OF A MULTI-CELL ARRANGEMENT MAINTAIN A HIGHER DESTRUCTION RATE CONSTANT, WITH THE RATE OF BOD REDUCTION BEING DESCRIBED AS A FIRST ORDER EQUATION. THE RATE DROPS OFF WITH EACH SUCCESSIVE CELL IN A MULTI-CELL ARRANGEMENT.

TERTIARY METHODS OF WASTE TREATMENT.
SIMPSON, J. R.; TRUESDALE, G. A.; BARUCHELLO, L.
BALFOUR-ITALIA, ROME (ITALY).
IN: PROCEEDINGS XV EUCEPA CONFERENCE ON HARMONIZING PULP AND PAPER INDUSTRY WITH ENVIRONMENT, HELD IN ROME, MAY 7 TO 11, 1973, P 523-533, 1973. 1 TAB, 3 REF.
MICROSTRAINERS, IMMEDIUM FILTER, SIMATER FILTER.
05D;03E;05G
AFTER FULL-SCALE BIOLOGICAL TREATMENT OF EFFLUENTS TO AT LEAST 20 MG/LITER OF BOD AND 30 MG/LITER OF TOTAL SUSPENDED SOLIDS (TSS), RESIDUAL OBJECTIONABLE CONSTITUENTS MAY REQUIRE FURTHER TREATMENT. SUCH TERTIARY PROCESSING CANNOT BE JUSTIFIED SOLELY FOR IMPROVING THE EFFLUENT QUALITY OF AN INEFFICIENT SECONDARY TREATMENT SYSTEM, SINCE THE CAPITAL COSTS FOR ACHIEVING ULTIMATE BOD AND TSS VALUES OF 10 AND A FINAL AMMONIA N CONTENT OF 3.5 MG/LITER ARE 25% HIGHER THAN THOSE FOR BOD REDUCTION TO 20 AND TSS REDUCTION TO 30 MG/LITER. VARIOUS TERTIARY POLISHING METHODS ARE COMPARED, INCLUDING IRRIGATION OVER GRASSLANDS, LAGOONING, SLOW AND RAPID GRAVITY SAND FILTERS, 'IMMEDIUM' UPWARD-FLOW AND 'SIMATER' RADIAL-FLOW SAND FILTERS, MICROSTRAINERS, GRAVEL-BED CLARIFIERS, AND BACTERIA REMOVAL.

LOW-COST WAYS OF STABILIZING LIQUID AND SOLID ORGANIC WASTES.
SNELL, J. R.
SNELL (JOHN R.) ENGINEERS, INC., LANSING, MICH.
WATER AND WASTES ENGINEERING, VOL 7, NO 5, P 54-57, MAY 1970. 2 FIG.
*AEROBIC DIGESTION, *CLARIFIER, COMPOST, VINYL, *CONTACT AERATION, AGITATION, SUSPENDED SOLIDS, THICKENING, *CHICAGO.
05D
THE WASTEWATER TREATMENT LAGOON HAS BEEN GENERALLY ACCEPTED AS A LOW-COST APPROACH TO WASTE TREATMENT, BUT ODORS CAUSED BY THIS PROCESS SOMETIMES CAUSE PROBLEMS. THE CONTACT AERATION PROCESS MAY BE DESIGNED

AT ONE HALF TO TWO THIRDS THE COST OF THE STANDARD ACTIVATED SLUDGE PROCESS AND ACCOMPLISH THE SAME DEGREE OF TREATMENT. THE CHICAGO SANITARY DISTRICT EXPECTS TO SAVE ABOUT TWO THIRDS OF THE COST OF INCINERATING THEIR SOLID WASTE BY: (1) THICKENING THE SLUDGE, (2) DIGESTING IT ANAEROBICALLY; (3) PUMPING IT THROUGH A PIPELINE, FIRST 50, THEN 150 MILES, WITH FINAL DISPOSAL BY LAND RECLAMATION. FURTHER MODIFICATIONS OF THE COMPOSTING METHOD HAVE ALSO BEEN DEVELOPED TO GIVE MUCH GREATER SAVINGS. WORK HAS BEEN DONE ON A LOW-COST APPROACH TO THE ANAEROBIC DIGESTION PROCESS FOR EITHER THE SETTLED SOLIDS OR THE TOTAL WASTE. FOUR LAGOONS, AVERAGING MORE THAN TWO ACRES EACH WERE DESIGNED AND BUILT, AND EACH LAGOON WAS COVERED WITH A 30 MIL. THICKNESS OF VINYL OR RUBBER TO KEEP OXYGEN OUT AND ODORS AND GASES IN. IN ADDITION, SEVERAL WORKABLE LOW-COST ALTERNATIVES TO THE CONVENTIONAL CLARIFIER HAVE BEEN FOUND. THE MOST PROMISING IS A 'TUBE' CLARIFIER MADE OF SMOOTH CORRUGATED SHEETS OF FIBERGLASS ROOFING, HELD ON ABOUT 3-TO-4 INCH CENTERS AT 60 DEGREES TO THE HORIZONTAL. THESE AND OTHER WASTE TREATMENT PROBLEMS WILL CONTINUE TO BE SUBJECT TO COST AND TECHNOLOGY BREAKTHROUGHS AS RESEARCH AND EXPERIENCE PROGRESSES. (BIGGS-TEXAS)

KINETICS OF ALGAL SYSTEMS IN WASTE TREATMENT--AMMONIA-NITROGEN AS A GROWTH LIMITING FACTOR AND OTHER PERTINENT TOPICS.
SOBSEY, M.; HARRISON, J. E.; GEE, H.; SHELEF, G.; GOLDMAN, J. C.
CALIFORNIA UNIV., BERKELEY. SANITARY ENGINEERING RESEARCH LAB.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE AS PB-206 811, $3.00 IN PAPER COPY, $0.95 IN MICROFICHE. FINAL REPORT, PART II, SEPTEMBER 1970, 156 P, 45 FIG, 11 TAB, 102 REF. FWQA PROGRAM 17010 DZO 09/70.
*OSTRACODS, PREDATOR-PREY RELATIONSHIPS, *AMMONIA-NITROGEN, *GROWTH REACTORS, ALGAL PONDS, ALGAL GROWTH RATES, *POTAMOCYPRIS.
05D;05C
4 SMALL OUTDOOR REACTORS, A PREDATOR INFESTED OUTDOOR POND, AND NUMEROUS INDOOR SYSTEMS WERE DESIGNED, CONSTRUCTED AND OPERATED TO PROVIDE DATA DESCRIBING THE KINETICS ASPECTS OF ALGAL SYSTEMS USED AS WASTEWATER TREATMENT SCHEMES. THE STUDIES INCLUDED DETERMINATIONS OF: (1) THE KINETICS OF AMMONIA-NITROGEN AS A GROWTH LIMITING FACTOR; (2) THE EFFECT OF NUTRIENTS IN WASTEWATER EFFLUENTS ON ALGAL GROWTH; (3) SUGGESTED DESIGNS FOR BOTH INDOOR AND OUTDOOR GROWTH REACTORS; AND (4) PREDATOR-PREY RELATIONSHIPS IN OUTDOOR ALGAL SYSTEMS. SPECIFIC GROWTH RATE DATA FOR NITROGEN WERE QUITE CONSISTENT, ALLOWING THE USE OF THE MAXIMUM SPECIFIC NET GROWTH RATE AS AN EXTREMELY RELIABLE PARAMETER OF SYSTEM OPERATION. PARAMETERS KA, KS, AND SN ALL DIRECTLY RELATED TO THE MAXIMUM SPECIFIC NET GROWTH RATE, WERE SHOWN TO BE USEFUL BOTH IN MATHEMATICAL INTERPRETATION OF SYSTEM KINETICS AND IN DETERMINING TO WHAT PERCENT OF CAPACITY AN ALGAL SYSTEM IS OPERATING. OTHER STUDIES DEMONSTRATED THAT PERMISSIBLE DILUTION RATIOS FOR WASTE WATER DISCHARGES INTO RECEIVING WATERS CAN BE FORMULATED EMPIRICALLY. DESIGN AND OPERATIONAL INFORMATION OF VARIOUS SYSTEMS IS PRESENTED, AS WELL AS PRELIMINARY BIOASSAY RESULTS ON THE MICROBIAL POPULATIONS OF ALGAL PONDS. (LOWRY-TEXAS)

OPERATION OF FULL-SCALE ANAEROBIC CONTACT TREATMENT PLANT FOR MEATPACKING WASTES.
STEFFEN, A. J.; BECKER, M.
WILSON AND CO., INC., ALBERT LEA, MN. ALBERT LEA WASTE TREATMENT PLANT.
IN: PROCEEDINGS 16TH INDUSTRIAL WASTE CONFERENCE, PURDUE UNIV., LAFAYETTE, INDIANA, ENGF. EXT. SER. NO 109, MAY 1961, P 423-437, 13 FIG, 2 TAB, 7 REF.
*MEAT PACKING WASTES, *ANAEROBIC CONTACT TREATMENT, *DEGASSIFICATION.
05D;05E
SINCE DECEMBER 1959, ALL OF THE WASTE FROM THE WILSON AND COMPANY MEAT PACKING PLANT AT ALBERT LEA, MINNESOTA HAS BEEN TREATED BY THE ANAEROBIC CONTACT PROCESS. THE DESIGN OF THIS TREATMENT PLANT, THE FIRST OF ITS KIND, WAS BASED UPON PILOT SCALE STUDIES CONDUCTED INITIALLY BY HORMEL AND COMPANY, AND LATER BY THE AMERICAN MEAT INSTITUTE AT AUSTIN, MINNESOTA, AND BY WILSON AND CO. AND ALBERT LEA. THE PROCESS TAKES ADVANTAGE OF THE FACT THAT ANAEROBIC ORGANISMS THRIVE BEST ON WARM (90 TO 95F TEMPERATURE), HIGH ORGAN SOLIDS WASTES. THE TREATMENT PLANT FLOW DIAGRAM IS SHOWN AND DISCUSSED. THE MAIN UNITS BEING AN EQUALIZER, 2 DEGASSIFIERS, AND ANAEROBIC DIGESTERS IN PARALLEL, 2 SLUDGE SEPARATORS IN SERIES, AND 2 OXIDATION LAGOONS IN SERIES. THE ANAEROBIC CONTACT PROCESS IS SIMILAR TO THE ACTIVATED SLUDGE PROCESS. THE EFFLUENT IS WELL WITHIN THE TOLERANCE OF 30 PPM BOD AND SUSPENDED SOLIDS, ESTABLISHED BY THE MINNESOTA WATER POLLUTION CONTROL COMMISSION, AND COMPARES FAVORABLY WITH RESULTS OBTAINED IN AEROBIC WASTE TREATMENT PROCESS. COMPLETE OPERATING DATA IS TABULATED AND GRAPHS PRESENTED OF RELATIVE PARAMETERS FOR THE DIGESTERS AND POLISHING LAGOONS. (PRODEHL-EPA, CORVALLIS)

A LABORATORY EVALUATION OF CHEMICAL COAGULATION AS A METHOD OF TREATING STABILIZATION POND EFFLUENT.
STEWART, JERRY
MISSISSIPPI STATE UNIV., STATE COLLEGE. DEPT. OF CIVIL ENGINEERING.
MASTER'S THESIS, AUGUST 1970. 73 P, 7 FIG, 5 TAB, 14 REF.
*ALUMINUM SULFATE, *FERRIC CHLORIDE, *FERRIC SULFATE, *STABILIZATION PONDS, ALUM, POST-TREATMENT.
05D
A LABORATORY STUDY WAS PERFORMED TO EVALUATE THE SUITABILITY OF CHEMICAL COAGULATION AS A POST TREATMENT METHOD FOR EFFLUENTS FROM WASTE STABILIZATION PONDS. THE DEGREE OF EFFECTIVENESS WAS MEASURED IN TERMS OF BIOCHEMICAL OXYGEN DEMAND, CHEMICAL OXYGEN DEMAND, TOTAL PHOSPHATES, TOTAL NITROGEN, COLIFORM COUNTS, AND ALGAL CELL COUNTS. THREE COAGULANTS: ALUMINUM SULFATE, FERRIC CHLORIDE, AND FERRIC SULFATE WERE EVALUATED. A MATHEMATICAL MODEL WAS CONSTRUCTED WHICH ALLOWED FOR THE COMPUTATION OF THE REQUIRED DOSAGE OF COAGULANT FOR VARIOUS INFLUENT AND EFFLUENT CONCENTRATION OF PHOSPHATES. THE RESULTS INDICATED THAT CHEMICAL COAGULATION WITH ALUM CAN BE EFFECTIVELY USED AS A POST TREATMENT METHOD OF STABILIZATION POND EFFLUENTS. NEARLY COMPLETE ALGAE REMOVAL, OVER 90 PERCENT BOD AND PHOSPHATE REMOVALS, OVER 70 PERCENT COD REMOVALS, AND AN AVERAGE OF 5,000 COLIFORMS/1000 ML., WERE OBTAINED USING AN ALUM DOSAGE OF 1000 MG/L. SETTLING CHARACTERISTICS OF THE ALUM-ALGAE SLUDGE WERE ALSO INVESTIGATED.

DESIGN CONSTRUCTION AND MAINTENANCE OF WASTE STABILIZATION LAGOONS.
STOLTENBERG, DAVID H.
FARMERS HOME ADMINISTRATION, CHAMPAIGN, ILL.
PUBLIC WORKS, VOL 101, NO 9, P 103-106, SEPTEMBER 1970. 4 FIG, 3 TAB, 17 REF.
DEPTH, SLOPE, *BOD LOADING, *WASTE STABILIZATION.
05D
THERE ARE SEVERAL IMPORTANT FACTORS INVOLVED IN WASTE STABILIZATION USING LAGOONS. THE FACT THAT OXYGEN IS PRODUCED BY ALGAE DURING THE DAY AND CONSUMED BY ALGAE AT NIGHT IS PRESENTED AS A CRITICAL FACTOR IN LAGOON DESIGN AND MAINTENANCE. THE VARIANCE OF ALLOWABLE BIOCHEMICAL OXYGEN DEMAND LOADING WITH GEOGRAPHICAL LOCATION IS ALSO DISCUSSED. CONSTRUCTION COSTS ARE ALSO PRESENTED. ESTIMATES RANGE FROM $11 TO $18 PER CAPITA FOR INSTALLATIONS SERVING 1000 PEOPLE, AND FROM $30 TO $36 PER CAPITA FOR INSTALLATIONS SERVING 100 PEOPLE. OPERATION AND MAINTENANCE COSTS ARE ESTIMATED TO BE ONE-FOURTH, OR ONE-FIFTH OF THE COST FOR CONVENTIONAL WASTE TREATMENT. (LOWRY-TEXAS)

UPGRADING LAGOON EFFLUENT FOR BEST PRACTICABLE TREATMENT.
STONE, R. W.; PARKER, D. S.; COTTERAL, J. A.
BROWN AND CALDWELL, WALNUT CREEK, CALIFORNIA.
JOURNAL WATER POLLTION CONTROL FEDERATION, VOL 47, NO 8, P 2019-2042, AUGUST, 1975. 16 FIG, 9 TAB, 11 REF.
DISSOLVED AIR FLOCATION, GRAVITY FILTRATION, BREAKPOINT CHLORINATION, *FIXED BED REACTORS, SAN FRANCISCO BAY(CALIF).
05D;05G
MODELING EFFORTS AND STUDIES PERFORMED BY THE UNIVERSITY OF CALIFORNIA'S SANITARY ENGINEERING RESEARCH LABORATORY OF BERKELEY, STATE AND FEDERAL AGENCIES, AND ENGINEERING CONSULTANTS HAVE DETETERMINED THAT THE WATER POLLUTION PROBLEMS ASSOCIATED WITH THE SOUTH BAY SEGMENT OF THE SAN FRANCISCO BAY SYSTEM MAY BE MITIGATED BY APPROPRIATE CONTROL MEASURES SUCH AS UPGRADING EXISTING TREATMENT FACILITIES TO A LEVEL OF QUALITY HIGHER THAN THAT DEFINED BY FEDERAL SECONDARY TREATMENT STANDARDS. THE POTENTIALLY FEASIBLE ALTERNATIVES FOR UPGRADING THE SUNNYVALE, CALIFORNIA, TREATMENT PLANT WERE IDENTIFIED. THE APPARENT BEST ALTERNATIVE PROJECT WAS DETERMINED TO BE TO ADD FIXED GROWTH REACTORS FOR NITRIFICATION AND DISSOLVED AIR FLOTATION AND GRAVITY FILTRATION FOR ALGA REMOVAL AND DECHLORINATION. PILOT PLANT STUDIES OF THE TERTIARY TREATMENT PROCESSES IDENTIFIED IN THE APPARENT BEST ALTERNATIVE PROJECT WERE STARTED IN SPRING 1973. STUDIES WERE PERFORMED ON DISSOLVED AIR FLOTATION, FILTRATION, BREAKPOINT CHLORINATION, AND NITRIFICATION USING FIXED GROWTH REACTORS. MAXIMUM ALLOWABLE LOADING RATES, CHEMICAL REQUIREMENTS, AND OPERATIONAL PARAMETERS WERE EVALUATED FOR EACH OF THE UNIT PROCESSES. A SCHEMATIC DRAWING OF EXISTING AND PROPOSED FACILITIES IS PRESENTED. (ORR-FIRL)

STREAM POLLUTION BY ALGAL NUTRIENTS,
STUMM, WERNER; MORGAN, JAMES J.
HARVARD UNIV., CAMBRIDGE, MASS. DIV. OF ENGINEERING AND APPLIED PHYSICS.
SANITARY ENGINEERING REPRINT NO. 45. TRANS 12TH ANN CONF SANITARY ENG, UNIV KANSAS, PP 16-26, 1962. 11

P. 3 FIG. 2 TAB. 19 REF.
MADISON(WIS).
05C
SINCE ORGANISMS ARE CONSUMED AS WELL AS PRODUCED, SIZE OF STANDING BIOMASS MAY BEAR LITTLE RELATION TO ORGANISM ACTIVITY RATE. AERODIC BIOLOGICAL SEWAGE TREATMENT MINERALIZES OXIDIZABLE ORGANIC SUBSTANCES BUT ELIMINATES ONLY 20-50% OF NITROGEN AND PHOSPHORUS COMPOUNDS. IN SEWAGE TREATMENT, CARBON BECOMES LIMITING BEFORE NITROGEN AND PHOSPHORUS ARE INCORPORATED INTO SLUDGE. INCREASE OF PHOSPHORUS FROM DETERGENTS MAY REACH POINT WHERE PHOSPHORUS COULD NO LONGER BE CONSIDERED A LIMITING FACTOR. SEWAGE STABILIZATION PONDS REPRESENT MIXTURE OF BACTERIAL DECOMPOSITION AND ALGAL GROWTH, BUT, TO REMOVE NITROGEN AND PHOSPHORUS, ALGAE MUST BE SEPARATED FROM POND EFFLUENT. DECOMPOSITION OF PHYTOPLANKTON WHICH SETTLED TO BOTTOM OF LAKE HELPS INCREASE NUTRIENT CONTENT OF BOTTOM WATERS DURING STAGNATION PERIODS. NOT ALL NUTRIENTS ARE REGENERATED. MADISON, WIS, LAKES RETAIN 30-60% OF NITROGEN RECEIVED. CONTRASTED WITH STABILIZATION PONDS, LAKE STAGNATION TENDS TO SEPARATE AUTOTROPHS (ALGAE) FROM HETEROTROPHS (BACTERIA AND ANIMALS). RELATION BETWEEN FERTILIZATION AND ALGAE IS INDICATED BY ASSUMPTION THAT EVERY ION OF PHOSPHORUS ADDED TO WATER, IF COMPLETELY UTILIZED FOR PHOTOSYNTHETIC PRODUCTION, CAUSES USE OF 16 NITROGEN ATOMS AND 106 ATOMS OF CARBON ALGAL PROTOPLASM. COMPLETE OXIDATION OF ORGANIC MATTER CONTAINING ONE ATOM OF PHOSPHORUS REQUIRES 150 MOLECULES OF OXYGEN. NUTRIENT REMOVAL METHODS ARE REVIEWED. (EICHHORN-WISC)

WASTEWATER PURIFICATION IN BIOLOGICAL TREATMENT PONDS WITH ALGAL GROWTH (OCHISTKA STOCHNJIKH VOD V APBGAPIZIROBANNJIKH BIOPRUDAKH)
TERESHINA, A. N.
VODOSNABZHENIE I SANITARNAIA TEKHNIKA, NO. 9, P 25-26, 1977. 1 TAB, 9 REF.
FIELD 05D
EXPERIENCES WITH THE USE OF ALGAL PONDS IN THE BIOLOGICAL TREATMENT OF MUNICIPAL WASTE WATER ARE PRESENTED. THE ALGAL PONDS HAVE DEPTHS IN THE RANGE OF 0.6-0.9 M AND ARE SECTIONED. THEY ARE ESTABLISHED ON IMPERMEABLE GROUND WHERE POSSIBLE AND ARE SEALED WITH POLYETHYLENE FOIL IN PERMEABLE REGIONS. THEY ARE INITIALLY SEEDED WITH ALGAE (CYANOPHYTA, DIATOMACA, AND CHLOROPHYTA) AT A DOSAGE OF 300 MG/25 CU M OF WATER. THE WASTE WATER THROUGHPUT IS GENERALLY IN THE RANGE OF 400-1,000 CU M/DAY AT A HYDRALLIC LOAD OF 800-1,375 CU M/HA/DAY AND AN ORGANIC MATTER LOAD OF 106-137 KG/HA/DAY. AFTER 99.9% OF THE E. COLI ARE DESTROYED, THE TREATED WASTE WATER IS DRAINED OFF VIA PIPES INSTALLED ABOVE THE BOTTOM. THE TREATMENT EFFICIENCY AND CHLOROPHYLL SYNTHESIS RATES ARE COMPARABLE FOR ALGAL PONDS IN THE BALTIC REGION AND IN CENTRAL ASIA, IN SPITE OF THE CONSIDERABLE DIFFERENCES IN CLIMATE AND TEMPERATURE.

OBSERVATIONS ON THE PERFORMANCE OF POLISHING LAGOONS AT A LARGE REGIONAL WORKS.
TOMS, I. P.; OWENS, M.; HALL, J. A.; MINDENHALL, M. J.
WATER POLLUTION RESEARCH LAB., STEVENAGE (ENGLAND).
WATER POLLUTION CONTROL, VOL 74, NO 4, P 383-401, 1975. 14 FIG, 9 TAB, 20 REF.
PHOSPHORUS REMOVAL, EFFLUENT POLISHING.
05D
THE USE OF LAGOONING AS A POLISHING PROCESS WAS CONSIDERED, IN TERMS OF NUMBER OF LAGOONS, THEIR RETENTION PERIODS, AND DEPTHS REQUIRED. GENERALLY, EXCEPT FOR THE REMOVAL OF PHOSPHATE AND AMMONIA, IT WAS FOUND THAT SEVERAL LAGOONS IN SERIES ARE BETTER THAN A SINGLE LAGOON OF THE SAME TOTAL RETENTION PERIOD. THE LAGOONS AT RYE MEADS SEWAGE PURIFICATION WORKS, GREAT BRITAIN, WERE USED FOR THIS STUDY WITH THE FOLLOWING CONCLUSIONS. WHILE LAGOONING OF SEWAGE EFFLUENT CAN BE AN EFFICIENT PROCESS FOR REDUCING SUSPENDED SOLIDS, BOD, FECAL BACTERIA, NITRATE, AND PHOSPHATE, MANY OF THE REQUIRED PERFORMANCE CHARACTERISTICS ARE NOT COMPATIBLE. THUS, FOR THE REMOVAL OF THE MAXIMUM AMOUNTS OF SS, BOD, AND FECAL BACTERIA, LAGOONS SHOULD BE OPERATED IN SERIES. BECAUSE THE GROWTH OF PHYTOPLANKTON INCREASES SS AND BOD AND REDUCES THE MORTALITY OF FECAL BACTERIA, IT SHOULD BE MINIMIZED BY USING A TOTAL RETENTION PERIOD OF UP TO FOUR DAYS IN SMALL CONSECUTIVE LAGOONS. FECAL BACTERIA REMOVAL (DUE TO AMOUNT OF DAYLIGHT) WILL BE GREATEST IN SUMMER; IN SHORT-RETENTION SERIES LAGOONS, SS REMOVAL IS NOT DEPENDENT UPON THE SEASON. CONDITIONS WHICH FAVOR THE MAXIMUM REMOVAL OF NITRATE ARE THE EXPOSURE OF WATER TO A MAXIMAL SURFACE OF MUD. REMOVAL RATES UP TO 0.8 G N/SQ M DAY ARE EXPECTED WHEN DENITRIFICATION IS PERFORMED AT THE MUD/WATER INTERFACE. MAXIMUM PHOSPHORUS REMOVAL IS POSSIBLE WHEN ALGAE POPULATIONS ARE AT THEIR MAXIMUM; THEIR GROWTH INCREASES THE PH OF THE WATER AND CAUSES PRECIPITATION OF P AS HYDROXYAPATITE. WHILE THIS ALGAL GROWTH OCCURS MOST RAPIDLY DURING LONG (10 DAYS OR MORE) RETENTION PERIODS IN SINGLE SHALLOW LAGOONS IN THE SUMMER, UNACCEPTABLE SS AND BOD MAY RESULT. ALL OF THESE FINDINGS ARE APPLICABLE TO THE 'POLISHING' OF ALMOST FULLY NITRIFIED EFFLUENTS.

BIOLCGICAL PARAMETERS FOR THE OPERATION AND CONTROL OF OXIDATION PONDS-II.
TSCHORTNER, U. S.
DEPARTMENT OF INDUSTRIES, CAPE TOWN (SOUTH AFRICA). DIV. OF SEA FISHERIES.
WATER RESEARCH, VOL 2, P 327-346, 1968. 9 FIG, 7 TAB, 24 REF.
C5D
OXIDATION PONDS ARE AN ECONOMICAL MEANS OF TREATMENT FOR DOMESTIC SEWAGE AND INDUSTRIAL WASTE EFFLUENTS, AND ARE WIDELY USED IN THE LESS POPULATED AREAS OF WARMER CLIMATES. THEIR ACTION RESEMBLES THE NATURAL PURIFICATION PROCESS OF POLLUTED RIVER. THEY REQUIRE LESS ATTENTION AND SKILLED STAFF THAN MECHANICAL SYSTEMS. THE SUCCESSFUL PERFORMANCE OF STABILIZATION, HOWEVER, DEPENDS ON THE BIOLOGICAL BALANCE OF THE SYSTEM. THE PRESENT STUDY DESCRIBES THE DEVELOPMENT OF PARAMETERS FOR THE DETERMINATION OF THE OXYGEN-PRODUCING COMMUNITY (PARAMETERS A AND AP) AND THE EFFICIENCY OF THE POND ON THE BREAKING DOWN OF THE LOAD (PARAMETER E). PARAMETER A REVEALS THE RELATIVE FRACTION OF CHLOROPHYLL-BEARING ORGANISMS OF THE TOTAL LOAD AND ALLOWS A DIRECT MEASUREMENT OF AUTOTROPHIC POND PERFORMANCE. PARAMETER AP REVEALS THE RATE OF PHOTOSYNTHESIS AND DOES NOT DEPEND ON VARIATIONS OF CHLOROPHYLL-A CONTENT OF CELLS. PARAMETER E IS BASED ON THE METABOLISM OF ALGAE AND CRUSTACEOUS; IT ESTIMATES THE CONTRIBUTION OF BOTH TO THE MICROPOPULATION AND INDICATES THE EFFECTIVENESS OF ALGAE IN REMOVING POLLUTION. COMPARISON OF THE COD CONTRIBUTED BY DISSOLVED AND SUSPENDED SOLIDS, WITH THE CALCULATED VALUES FOR ALGAE AND NON-ALGAL MATTER OF THE SUSPENDED FRACTION, REVEALED THAT IN A WELL-BALANCED SYSTEM MORE THAN HALF OF THE TOTAL COD IS CONTRIBUTED BY ALGAL CELLS. THE FIGURE IN THE OVERLOADED PONDS BEING ONLY 20%.

UPGRADING WASTEWATER STABILIZATION PONDS TO MEET NEW DISCHARGE STANDARDS.
UTAH WATER RESEARCH LAB., LOGAN.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161, AS PB-240 402,$7.50 IN PAPER COPY, $2.25 IN MICROFICHE. ENVIRONMENTAL PROTECTION AGENCY, REPORT EPA-670/9-75-004, (MARCH 1975), 244 P (PROCEEDINGS OF A SYMPOSIUM HELD IN NOVEMBER 1974). EPA 1BB043 (21ASR-119) R-803294-01-0.
-SAND FILTRATION, CONTROLLED DISCHARGE(WASTES), ROCK FILTRATION, LAND DISPOSAL.
C5D;C5G
THE QUESTION AS TO WHETHER LAGOONS, AS THEY NOW EXIST, MEET THE NEW SECONDARY TREATMENT STANDARDS AND WHAT METHODS WOULD WORK TO UPGRADE LAGOON TREATMENT IN CASES WHERE THEY PRESENTLY DO NOT MEET THE STANDARDS IS OF HIGH PRIORITY FOR MANY REGIONAL OFFICES OF EPA. THE SYMPOSIUM WAS HELD FOR EPA STAFF AND STATE OFFICIALS TO REVIEW THE OFFICE OF RESEARCH AND DEVELOPMENT'S PROGRAM FOR UPGRADING LAGOONS. THE INTERMITTENT SAND FILTER, LAND APPLICATION OF ALGAE LADEN EFFLUENTS AND THE SUBMERGED ROCK FILTER OFFER GOOD POTENTIAL FOR COST EFFECTIVE UPGRADING. THE BASIC BIOLOGY OF THE TREATMENT MECHANISM, DISINFECTION TECHNOLOGY, THE CONTROLLED DISCHARGE OPERATION (AND RESULTS), COST EFFECTIVE ANALYSIS, AND NEW FIELDS OF RESEARCH WERE COVERED. INTERMITTENT SAND FILTRATION, SUBMERGED ROCK FILTRATION, AND LAND APPLICATION OF SEWAGE EFFLUENTS ARE EFFECTIVE ALTERNATIVES TO REMOVING ALGAE FROM SEWAGE LAGOONS.

LIQUID WASTE TREATMENT PROCESS.
VALDESPINO, J. M.
U. S. PATENT NO. 3,625,883, 5 P, 3 FIG, 11 REF, OFFICIAL GAZETTE, VOL. 893, NO. 1, P. 254, DECEMBER 7, 1971.
AEROBIC BIOLOGICAL DEGRADATION.
C5D
A METHOD IS DESCRIBED FOR THE TREATMENT OF LIQUID WASTE FROM DOMESTIC AND INDUSTRIAL SOURCES. THE LIQUID WASTE IS FIRST FED TO A COMMINUTOR FOR CHOPPING AND MIXING SOLID WASTE WITH THE LIQUID. THE PRODUCT IS THEN FED TO A SURGING TANK FOR PROVIDING AN INTERMITTENT FLOW INTO A CENTRIFUGING STEP. THE WASTE IS CENTRIFUGED THROUGH A FILTER MEDIUM SUCH AS SAND OR DIATOMACEOUS EARTH. THE SEPARATED EFFLUENT IS FED TO AN OXIDATION LAGOON FOR AEROBIC BIOLOGICAL DEGRADATION. THE GENERATION OF ALGAE MAY BE PROVIDED TO REMOVE PHOSPHATES, NITRATES AND OTHER NUTRIENTS. THE EFFLUENT THEN IS FED TO A SECOND CENTRIFUGE FILTER TO SEPARATE REMAINING SOLIDS WHICH ARE BURNED. CHLORINATION PROVISIONS ARE INCLUDED.

KINETICS OF OXYGEN UPTAKE BY DEAD ALGAE.
VARMA, MAN M.; DIGIANO, FRANCIS
HOWARD UNIV., WASHINGTON, D.C. DEPT. OF CIVIL ENGINEERING.
JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 40, NO 4, P 613-626, APRIL 1968. 11 FIG, 6 TAB, 16 REF.
*UPTAKE, CELLS, CONCENTRATION, COMPOSITION, MATERIAL BALANCES, ORGANISMS.
C5D

THE RATE OF OXYGEN UPTAKE BY DEAD ALGAL CELLS IS INDEPENDENT OF THE ALGAL CELL CONCENTRATION. THE RATE OF UPTAKE BY YOUNG CELLS IS GREATER THAN THAT BY OLD CELLS. RATES INCREASE WITH TEMPERATURE UP TO ABOUT 35 DEG C, THEN DECREASE SHARPLY. INCREASED BACTERIAL POPULATION WILL INCREASE THE BIODEGRADATION OF THE DEAD ALGAE. UPTAKE RATES OBSERVED RANGED FROM 0.008 MICRO _ O SUB 2/MIN/MG ALGAE FOR OLD CELLS AT 20 DEG C TO 0.294 MICRO L O SUB 2/MIN/MG ALGAE FOR YOUNG CELLS AT 35 DEG C. MATERIAL BALANCES SHOWED THAT THE TOTAL ACTUAL OXYGEN UPTAKE WAS LESS THAN THE TOTAL OXYGEN REQUIRED FOR COMPLETE DEGRADATION OF THE SUBSTRATE BECAUSE OXIDATION WAS INCOMPLETE. (AGUIRRE-TEXAS)

MICROBIOLOGIC INDICATORS OF THE EFFICIENCY OF AN AERATED, CONTINUOUS-DISCHARGE, SEWAGE LAGOON IN NORTHERN CLIMATES.
VENNES, J. W.; OLSON, O. O.
NORTH DAKOTA UNIV., GRAND FORKS. SCHOOL OF MEDICINE.
IN: INTERNATIONAL SYMPOSIUM ON WATER POLLUTION CONTROL IN COLD CLIMATES, JULY 22-24, 1970. UNIVERSITY OF ALASKA, COLLEGE, P 286-311. 4 TAB, 5 REF, APPEND.
*CONTINUOUS DISCHARGE LAGOON.
05D:05C:02C
THE AERATED LAGOON, A DEVELOPMENT IN BIOLOGICAL WASTE TREATMENT WAS STUDIED IN HARVEY, NORTH DAKOTA. COLIFORM, FECAL COLIFORM, AND ENTEROCOCCI WERE DETERMINED AS WELL AS BOD, NITROGEN, PH, TOTAL AND SUSPENDED SOLIDS; AND TOTAL BACTERIAL POPULATIONS ENUMERATED. LAGOON EFFICIENCY DEPENDS ON TEMPERATURE AND OXYGEN; THEIR EFFECT ON BIOLOGIC STABILIZATION IS DETERMINED AND THE FINDINGS ARE REFLECTED IN RELATIVE ABUNDANCE OF SEVERAL MICROBIAL SPECIES AND IN BOD. COLIFORM, FECAL COLIFORM, AND ENTEROCOCCAL NUMBERS IN THE SECONDARY LAGOON DURING ZERO CENTIGRADE TEMPERATURES WERE DIRECTLY RELATED TO BOD AND TOTAL NITROGEN. DURING SUMMER TEMPERATURES, LITTLE CORRELATION BETWEEN THESE ORGANISMS AND BOD AND TOTAL NITROGEN WAS NOTED. THERE WAS A CORRELATION BETWEEN THE TOTAL MICROBIAL POPULATION AND BOD AT SUMMER TEMPERATURES. SINCE ONLY 1% OR LESS OF THE TOTAL MICROBIAL POPULATION IS REPRESENTED BY THE ENTERIC ORGANISMS STUDIED, IT IS APPARENT THAT OTHER ORGANISMS MUST BE STUDIED TO DEFINE BETTER THE ROLE OF MICROBIOLOGIC INDICATORS IN THE EFFICIENCY OF THIS SEWAGE TREATMENT SYSTEM. A SYSTEM CONCERNED WITH PRODUCTION AND UTILIZATION OF THE VITANIN B, BIOTIN, IS BEING STUDIED, SINCE IT RELATES TO SEVERAL ORGANISMS THAT THRIVE IN SEWAGE OXIDATION LAGOONS.

STATE OF THE ART-OXIDATION PONDS.
VENNES, JOHN W.
NORTH DAKOTA UNIV., GRAND FORKS. DEPT. OF MICROBIOLOGY.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 366-376. 3 TAB, 67 REF.
05D
AN INTENSIVE LITERATURE SEARCH OF THE WASTE STABILIZATION POND METHOD OF TREATING WASTE WATER WAS CONDUCTED TO DETERMINE THE PRESENT STATUS OF SUCH UNITS WITH REGARD TO DESIGN CRITERIA, OPERATIONAL PARAMETERS, AND COMPLIANCE WITH WATER POLLUTION PREVENTION REGULATIONS. DESIGN CONSIDERATIONS ARRIVED AT WERE: (1) 1 LANGLEY/DAY OF RADIATION IS SUFFICIENT TO TREAT 1 LB BOD/ACRE/DAY; (2) MULTI-STAGE SERIES PONDS PROVIDE THE BEST ORGANIC AND BACTERIAL REMOVALS; (3) SEEPAGE AND EVAPORATION MUST BE CONSIDERED IN LAGOON DESIGN SINCE IN MANY CASES THESE ARE THE ONLY FORMS OF EFFLUENT; (4) CHLORINATION WHILE KILLING THE BACTERIA, WILL ALSO KILL THE ALGAE WHICH WILL THEN EFFECT AN IMMEDIATE ORGANIC LOAD ON THE SYSTEM OR THE RECEIVING STREAM; (5) ALGAE REMOVAL TECHNIQUES MUST BE DEVELOPED SINCE MOST OF THE ORGANIC MATERIAL IS NOT DESTROYED, BUT MERELY CONVERTED TO ALGAE, AS ARE THE INORGANIC NUTRIENTS AS WELL. WITHOUT ALGAE REMOVAL, OXIDATION POND EFFLUENT IS HIGH IN ORGANIC CONTENT WHICH MAY CAUSE DETERIORATION OF THE RECEIVING STREAM QUALITY. MORE STUDY IS NEEDED ON THE MECHANISMS WHICH ARE UTILIZED IN OXIDATION PONDS FOR THE REMOVAL OF ORGANICS, AND ALSO ON THE ACTUAL MEASUREMENT OF THE ORGANIC LOADINGS ON THE FACILITIES BEFORE ORGANIC POLLUTANTS AND MICRO-ORGANISMS PRESENT IN POND EFFLUENTS CAN BE RELIABLY PREDICTED.

PHYTOPLANKTON ENERGETICS IN A SEWAGE-TREATMENT LAGOON.
VERDUIN, JACOB
SOUTHERN ILLINOIS UNIV., CARBONDALE. DEPT. OF BOTANY.
ECOLOGY, VOL 52, NO 4, P 626-631, 1971. 5 FIG, 3 TAB, 20 REF. NSF GE-2649.
EXTINCTION COEFFICIENT, LAMBERT-BEER EQUATION, EDDY DIFFUSIVITY, DESHLER(OHIO).
05D
INTENSIVE INVESTIGATIONS WERE CARRIED OUT FROM MARCH 21 THROUGH JUNE 10, 1964 OF A SEWAGE-TREATMENT LAGOON SYSTEM NEAR DESHLER, OHIO--A PERIOD CRITICAL FOR SEWAGE PONDS IN THE TEMPERATE ZONE. THE PONDS

WERE WELL MIXED VERTICALLY, EXHIBITED DAYTIME AVERAGE EDDY DIFFUSIVITIES OF ABOUT 1 SQ CM/SEC AND HAD A HIGH TITRATABLE BASE. LOW OXYGEN LEVELS WERE ENCOUNTERED FOR ONLY A SHORT PERIOD IN THE SECOND STAGE OF THE TWO-POND SYSTEM. LIGHT ABSORPTION AVERAGED ABOUT 90%/M. THE PHYTOPLANKTON COMMUNITIES, DOMINATED BY SCENEDESMUS, ROSE TO 50 MICROLITERS/L. RATES OF CARBON DIOXIDE UPTAKE IN THE ORDER OF 1 M/CM PER DAY WERE OBSERVED, BUT OXYGEN PRODUCTION AVERAGED ONLY 1/5 AS HIGH. A GRAPH OF CARBON DIOXIDE UPTAKE VERSUS LIGHT INTENSITY REVEALED A CURVE CLOSELY SIMILAR IN SHAPE TO THE TYPICAL PHOTOSYNTHESIS VERSUS LIGHT CURVE, BUT A SPEARATE SET OF DATA, BASED ON C-14 UPTAKE, SHOWED ANOMALOUSLY HIGH VALUES AT SURFACE LIGHT INTENSITIES. CARBON DIOXIDE UPTAKE BY A PHOTOSYNTHETIC METABOLIC PROCESS THAT DOES NOT PRODUCE OXYGEN IS POSTULATED TO EXPLAIN THE IMBALANCE BETWEEN CARBON DIOXIDE AND OXYGEN BUDGETS.

TERTIARY TREATMENT BY AERATED LAGOON.
WAHBEH, V. N.; WELLER, L. W.
2ND INTERNATIONAL SYMPOSIUM FOR WASTE TREATMENT LAGOONS, JUNE 23-25, 1970, KANSAS CITY, MISSOURI, P 253-255. 11 FIG, 3 TAB, 5 REF.
*AERATED LAGOONS, SUSPENDED SOLIDS.
05D
AN OXIDATION POND, ORIGINALLY DESIGNED AS THE TREATMENT FACILITY FOR A SMALL COMMUNITY AND LATER SUPERCEDED BY A HIGH-RATE TRICKLING FILTER PLANT, WAS REMODELED AND EQUIPPED WITH DIFFUSED AIR AERATION USING THREE 600 CFM BLOWERS. THIS UNIT PROVIDED TREATMENT MAINLY FOR STORM BYPASS, UNTIL IT WAS UTILIZED AS A TERTIARY STAGE TO FOLLOW THE TRICKLING FILTER. TESTS WERE THEN CONDUCTED, USING AN AUTOMATIC SAMPLING DEVICE, TO DETERMINE THE EFFICIENCY OF SUCH AN ARRANGEMENT DURING SEVERAL SHORT TESTING PERIODS. IT WAS DISCOVERED THAT CONVENTIONAL OXIDATION PONDS LACKING AERATION WERE INEFFECTIVE IN REDUCTION OF BOD, SUSPENDED SOLIDS, AND INORGANIC NUTRIENTS UNLESS SOME METHOD OF ALGAE HARVESTING WAS EMPLOYED. AERATED LAGOONS, HOWEVER, PROVIDED IN EXCESS OF 60% REDUCTION OF BOD AND SUSPENDED SOLIDS, ALTHOUGH NO DETECTABLE REDUCTION IN INORGANIC NUTRIENTS WAS EVIDENCED. SOME CRITICAL PARAMETERS FOR DESIGN OF AERATED LAGOONS ARE (1) GREATER THAN 4:1 AND PREFERABLY A 2:1 SIDE SLOPE TO PREVENT SOLIDS DEPOSITION ON THE SLOPE, AND (2) MINIMIZATION OF WATER SURFACE AREA PREVENTS UNWANTED ALGAL CELL GROWTH WHICH OTHERWISE WOULD DEFEAT THE PURPOSE OF THE USE OF AERATED LAGOONS INSTEAD OF OXIDATION LAGOONS.

EXPERIMENTAL TREATMENT OF SURFACE WATER PURIFICATION BY LAGOONS: CHEMICAL AND MICROBIOLOGICAL ASPECTS. (TRAITEMENT EXPERIMENTAL D'EPURATION D'UNE EAU DE SURFACE PAR LANUNAGE: ASPECTS CHIMIQUES ET MICROBIOLOGIQUES).
WALKER, J.; LECLERC, H.
INSTITUT PASTEUR, LILLE (FRANCE). LABORATOIRE D'HYDROBIOLOGIE.
WATER RESEARCH, VOL 7, NO 5, P 707-728, MAY 1973. 14 FIG, 6 TAB, 48 REF.
*BACTERIAL POPULATIONS, ENTEROBACTERIACEAE, AEROMONAS, ACHROMOBACTER, FLAVOBACTERIUM, XANTHOMONAS, CYTOPHAGA, FECAL POLLUTION, POTASSIUM PERMANGANATE CONSUMPTION, ORTHOPHOSPHATES, CARBON CHLOROFORM EXTRACT, ORGANIC NITROGEN, FECAL STREPTOCOCCI.
05B;05A
POLLUTED RIVER WATER WAS TREATED BY LAGOONING IN AN EXPERIMENTAL BED. THE EVOLUTION OF THE MOST REPRESENTATIVE PARAMETERS OF THE ORGANIC AND BACTERIAL POLLUTION HAS BEEN STUDIED IN RELATION TO THE PERIOD OF RETENTION. THE PREDOMINANT BACTERIAL POPULATIONS HAVE BEEN IDENTIFIED AND THEIR QUALITATIVE AND QUANTITATIVE VARIATIONS HAVE BEEN RELATED TO THE DEGREE OF POLLUTION. THE ANALYTICAL RESULTS ARE COMMENTED UPON AND THE ADVANTAGES OF THE METHOD ARE STRESSED. (HOLDMAN-BATTELLE)

PROGRESS REPORT: BLUE SPRINGS LAGOON STUDY, BLUE SPRINGS, MISSOURI.
WALTER, C. M.; BUGBEE, S. L.
ENVIRONMENTAL PROTECTION AGENCY, KANSAS CITY, KANS. WATER QUALITY LAB.
IN: UPGRADING WASTEWATER STABILIZATION PONDS TO MEET NEW DISCHARGE STANDARDS, AUGUST 21-23, 1974, LOGAN, UTAH, UTAH STATE UNIVERSITY, P 191-197. 2 TAB, 1 REF.
BLUE SPRINGS(MO), FECAL COLIFORMS, THREE CELL SERIES OPERATED LAGOON, FEDERAL WATER POLLUTION CONTROL AMENDMENTS, NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM.
05D;05G
THE FEDERAL WATER POLLUTION CONTROL AMENDMENTS WERE PASSED IN 1972. THEY PROVIDED THE LEGISLATION FOR CONTROLLING THE DISCHARGE FROM MUNICIPAL AND INDUSTRIAL WASTE SOURCES. PERMITS GRANTED UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIRE SECONDARY TREATMENT BY 1977. STANDARDS ARE 30 MG/LITER FOR 5 DAY BIOCHEMICAL OXYGEN DEMAND (BOD(5)), 30 MG/LITER FOR SUSPENDED SOLIDS, AND 200

ORGANISMS/100 ML FOR COLIFORM DENSITIES. THESE STANDARDS WERE TESTED FOR THE THREE-CELL, IN A SERIES LAGOON SYSTEM AT BLUE SPRINGS, MISSOURI. THE OBJECTIVES OF THE TESTS WERE: TO DETERMINE THE PERFORMANCE OF A THREE-CELL, SERIES OPERATED, LAGOON; TO DETERMINE THE RELATIVE PERFORMANCE OF THE THREE CELLS; AND TO DETERMINE THE FEASIBILITY OF SLOW SAND FILTRATION. TWO SAND FILTERS WERE USED FOR THE TESTS, ONE WITH AN EFFECTIVE SAND SIZE OF 0.3 MM AND THE OTHER, 0.22 MM. LABORATORY ANALYSES WERE CONDUCTED FOR BIOCHEMICAL OXYGEN DEMAND, CHEMICAL OXYGEN DEMAND, SUSPENDED SOLIDS, NITROGEN, PHOSPHORUS, COLIFORMS AND VARIOUS METALS. DURING THE WINTER, 84% OF THE BOD(5) REMOVAL OCCURRED IN CELL 1 AND NONE IN CELLS 2 OR 3. CELLS 2 AND 3 REDUCED COD AND SUSPENDED SOLIDS BY 32% AND 23%, RESPECTIVELY. THE FECAL COLIFORM COUNT WAS REDUCED FROM 475,000 TO 22,000 ORGANISMS/100 ML. IN THE SPRING, BOD(5) REMOVAL WAS 80%. BOD(5) AND SUSPENDED SOLIDS CONCENTRATIONS BOTH MET THE SECONDARY TREATMENT CRITERIA, WHILE THE COLIFORMS WERE IN EXCESS OF THE LIMIT. DATA FOR THE SUMMER WERE IN THE PROCESS OF BEING GENERATED.

POLLUTION CONTROL PLANT STATISTICS
WATER AND POLLUTION CONTROL, VOL 115, NO 11, P 78-96, 98, 101-102, NOVEMBER, 1977. 13 TAB.
FIELD 05G, 05D
A COMPREHENSIVE LISTING OF CANADIAN MUNICIPAL WATER POLLUTION CONTROL FACILITIES IS PROVIDED IN TABULAR FORM. THE INFORMATION GIVEN FOR EACH FACILITY INCLUDES POPULATION SIZE, WHETHER THE MUNICIPALITY WAS AN INDUSTRIAL WASTE STRENGTH LIMITING BY-LAW, AVERAGE DAILY FLOW, AND WHETHER THE SYSTEM IS SEPARATE OR COMBINED. INFORMATION ON THE DEGREE OF TREATMENT, INFLUENT AND EFFLUENT BOD AND SUSPENDED SOLIDS, TYPE OF TREATMENT, SLUDGE PROCESSING, AND COST OF TREATMENT PER MILLION GALLONS OF WASTE WATER PROCESSED IS ALSO PROVIDED. TYPES OF TREATMENT COVERED INCLUDE: ALGAE LAGOONS, AERATED LAGOONS, ANEROBIC LAGOONS, PRIMARY SEDIMENTATION, CONVENTIONAL ACTIVATED SLUDGE, COMPLETELY MIXED SYSTEMS, CONTACT STABILIZATION, BIOLOGICAL FILTRATION, EXTENDED AERATION, AND SEPTIC TANKS. SLUDGE PROCESSING TECHNIQUES INCLUDE: HEATED DIGESTERS, DRYING BEDS, FILTRATION, CENTRIFUGING, AGRICULTURAL DISPOSAL, UNHEATED DIGESTERS, INCINERATION, LIQUID HAULAGE, DEEP WELL DISPOSAL, AND LAND-FILLING. SELECTED LISTINGS OF KEY MANAGEMENT AND OPERATING PERSONNEL RESPONSIBLE FOR POLLUTION CONTROL AT VARIOUS LOCATIONS IN CANADA ARE ALSO PROVIDED. (SNYDER-FIRL)

SOLAR ENERGY USED TO CONVERT WASTEWATER TO PROTEIN.
WATER AND WASTES ENGINEERING, VOL. 14, NO. 10, P 37, OCTOBER, 1977.
05D
BROWN AND CALDWELL HAS DEVELOPED A SYSTEM IN WHICH A WASTE WATER SUBSTRATE AND SOLAR ENERGY ARE USED TO PRODUCE A HIGH-QUALITY SINGLE CELL PROTEIN HARVESTED IN THE FORM OF ALGAE AND A USABLE LIQUID EFFLUENT. PRIMARY TREATED WASTE WATER IS SUBJECTED TO SECONDARY TREATMENT IN SHALLOW, HIGH-RATE OXIDATION PONDS AND THE RESULTING ALGAE IS HARVESTED WITH A DEVICE WHICH USES A PAPER-PRECOATED FILTER TO ENTRAP THE DENSE ALGAE PRODUCT. IN A YEAR-LONG STUDY IN MELBOURNE, AUSTRALIA, THE INITIAL OBJECTIVE WAS TO USE WASTE PAPER FOR THE HARVESTER BELT FABRIC; USED BELTS WERE THEN RECYCLED AS A COMPOSITE FEED FOR RUMINANT LIVESTOCK, THE PAPER PROVIDING ROUGHAGE AND ENERGY AND THE ALGAE PROVIDING PROTEIN. THE ALGAE-LADEN PAPER PRODUCT WAS REPORTED AS HAVING A PROTEIN CONTENT OF 15% BY WEIGHT. PROBLEMS ASSOCIATED WITH THE SMALLER SIZE OF INDIVIDUAL ALGAE CELLS PRODUCED IN WINTER AND WITH THE HIGH COST OF WASTE PAPER IN AUSTRALIA LED TO THE DEVELOPMENT OF A TWO-STAGE VACUUM AND RINSING CYCLE FOR THE SEPARATION OF ALGAE FROM POND EFFLUENT. IN THIS CASE A CONCENTRATED ALGAE SLURRY IS PRODUCED RATHER THAN A DRIED, ALGAE-LADEN PAPER. THE ALGAE RECOVERY SYSTEM IS RECOMMENDED FOR SITUATIONS WHERE FEED SUPPLIES ARE IN DEMAND AND HIGH-QUALITY SEWAGE TREATMENT IS INDICATED. (SCHULZ-FIRL)

ALGAL GROWTH IN RELATION TO NUTRIENTS.
WATER POLLUTION RESEARCH LAB., STEVENAGE (ENGLAND).
IN: POLLUTION OF FRESH WATERS - REPORT OF THE DIRECTOR 1971, P 25-31, 6 FIG, 3 TAB, 3 REF.
GRAFHAM WATER(ENGLAND), APHANIZOMENON, MICROCYSTIS.
05C
MARKED SEASONAL CHANGES IN AVERAGE CONCENTRATIONS OF OXIDIZED NITROGEN, SILICON, AND SOLUBLE ORTHOPHOSPHATE IN THE WATER COLUMNS HAVE BEEN OBSERVED, PARTICULARLY DURING ALGAL BLOOMS AND WHEN RESERVOIR WAS THERMALLY STRATIFIED. DURING THE BLOOM OF BLUE-GREEN ALGAE IN JULY AND AUGUST 1970, CONCENTRATIONS OF OXIDIZED NITROGEN AND PHOSPHORUS FELL. DURING THE SUBSEQUENT DIATOM BLOOM, SILICON AND PHOSPHORUS CONCENTRATIONS DECLINED, INCREASING AGAIN WHEN THE BLOOM ENDED IN DECEMBER. BETWEEN JUNE AND SEPTEMBER 1970 DURING THE BLOOM OF BLUE-GREEN ALGAE, ALGAE INCREASES NUMERICALLY. CHEMICAL AND BIOLOGICAL DATA REVEAL THAT WHENEVER THERE IS A DIATOM BLOOM THE SILICON CONTENT OF THE WATER FALLS, THE DIATOM POPULATION, EXPRESSED AS CHLOROPHYLL-A, DECLINES RAPIDLY. WHEN SILICON CONCENTRATION HAS

FALLEN TO 0.4-0.2 MG/L DURING DIATOM BLOOMS THERE IS A SIGNIFICANT REDUCTION IN SOLUBLE ORTHOSPHOSPHATE CONCENTRATION, BUT THAT OF OXIDIZED NITROGEN IS NOT MARKEDLY AFFECTED, AND DURING BLUE-GREEN ALGAL BLOOMS THE SOLUBLE ORTHOPHOSPHATE IS EXHAUSTED AND OXIDIZED NITROGEN CONCENTRATION FALLS TO ABOUT 0.5 MG/L. INVESTIGATION OF THE EFFECTS OF NUTRIENT LOADING AND RETENTION TIME ON ALGAL GROWTH IN LAGOONS AT RYE MEADS SEWAGE WORKS SHOWED EMERGENCE OF A MARKED RELATIONSHIP BETWEEN RETENTION TIME, ALGAL GROWTH, AND NUTRIENT DEPLETION IN LAGOONS WITH CONTINOUS SEWAGE EFFLUENT FLOW. (JONES-WISCONSIN)

HOW TO DESIGN AERATED LAGOON SYSTEMS TO MEET 1977 EFFLUENT STANDARDS.
WHITE, S. C.; RICH, L. G.
SOUTH CAROLINA DEPT. OF HEALTH AND ENVIRONMENTAL CONTROL, COLUMBIA.
WATER AND SEWAGE WORKS, VOL. 123, NO. 4, P 82-83, APRIL, 1976. 1 FIG, 1 TAB.
05D
AS PART OF A FOUR-PART SERIES ON EXPERIMENTAL STUDIES CONDUCTED IN SOUTH CAROLINA ON THE CONTROL OF SUSPENDED SOLIDS IN AERATED LAGOON EFFLUENTS, THIS PAPER SHOWS HOW THE RESULTS OF THE STUDIES ARE USED IN THE DESIGN OF AERATED LAGOON SYSTEMS WITH EFFLUENT STANDARDS. TWO CLASSES OF AERATED LAGOONS CURRENTLY IN USE ARE THE COMPLETELY-MIXED (OR COMPLETELY-SUSPENDED) AND THE FACULTATIVE (OR PARTIALLY-SUSPENDED) TYPES. THE COMPLETELY MIXED TYPE IS DISCUSSED IN DETAIL. AN EQUATION IS PROVIDED TO DEMONSTRATE HOW THE RESIDUAL SUBSTRATE FOUND IN THE EFFLUENT FROM A COMPLETELY MIXED SYSTEM IS BASED ON A STEADY-STATE MASS BALANCE OF AN ORGANIC SUBSTRATE. TEMPERATURES OF AERATED LAGOONS CAN BE ESTIMATED WITH A RELATIONSHIP DERIVED FROM A THERMAL ENERGY BALANCE ACROSS A COMPLETELY-MIXED SYSTEM; THE APPROPRIATE EQUATION IS PROVIDED. A GRAPH COMPARES POWER-LEVEL REQUIREMENTS FOR OXYGEN AND SOLIDS SUSPENSION IN A COMPLETELY-SUSPENDED AERATED LAGOON FITTED WITH SURFACE AERATORS TO TREAT A TYPICAL DOMESTIC WASTE WATER. IN A PARTIALLY-SUSPENDED (FACULTATIVE) AERATED LAGOON, OXYGEN REQUIREMENTS INCREASE, DUE TO BOD FEEDBACK FROM THE DEPOSITED SOLIDS. OXYGEN REQUIREMENTS MAY BE ESTIMATED FOR SUCH LAGOONS, WITH THE VALUE OF THE BOD REMOVED VARYING FROM WINTER TO SUMMER CONDITIONS. (KRAMER-FIRL)

HOW CHLORINE AFFECTS SOLUBLE COD IN ALGAL LADEN SYSTEMS
WIGHT, J. L.; JOHNSON, B. A.; REYNOLDS, J. H.; MIDDLEBROOKS, E. J.
WATER AND SEWAGE WORKS, VOL 125, NO 3, P 48-52, 54, MARCH, 1978. 14 FIG, 3 TAB, 20 REF.
FIELD 05D
THE IMPACT OF CHLORINATION ON SOLUBLE COD CONCENTRATIONS IN WASTE WATER CONTAINING HIGH LEVELS OF ALGAE WAS ANALYZED IN LABORATORY TESTS AND IN EXPERIMENTS CONDUCTED AT THE LOGAN CITY, ILLINOIS, MUNICIPAL SEWAGE TREATMENT LAGOONS. WHEN CHLORINE DOSES OF 4.2, 16.9, AND 50.8 MG/LITER, IN THE LABORATORY STUDIES, SOLUBLE COD CONCENTRATIONS IN THE CHLORINATED ALGAE-BEARING EFFLUENT INCREASED FROM AN INITIAL 24.31 MG/LITER TO A HIGH OF 38.73 MG/LITER AND FROM AN INITIAL 52.70 MG/LITER TO A HIGH OF 70.37 MG/LITER AFTER TREATMENT WITH CHLORINE AT A DOSE OF 50.8 MG/LITER. COD CONCENTRATIONS INCREASED SUBSTANTIALLY DURING THE FIRST 15 MIN OF CHLORINE CONTACT. CORRESPONDING INCREASES WERE NOT OBSERVED IN FIELD STUDIES OF COD CONCENTRATIONS AFTER CHLORINE DISINFECTION. IN FIELD EXPERIMENTS, SOLUBLE COD INCREASES IN ALGAL LADEN WASTE WATER WERE APPARENT ONLY FOR UNFILTERED SEWAGE LAGOON EFFLUENT HAVING A FREE CHLORINE RESIDUAL. OXIDATION OF ORGANIC SUBSTANCES BY FREE CHLORINE RESIDUAL. OXIDATION OF ORGANIC SUBSTANCES BY FREE CHLORINE RESIDUALS WHERE SAND FILTRATION WAS NOT EMPLOYED CONTRIBUTED TO THE SOLUBLE COD INCREASES. (LISK-FIRL)

LABOR-FREE MANURE DISPOSAL,
WILMORE, REX
PURDUE UNIV., LAFAYETTE, IND. DEPT. OF AGRICULTURAL ENGINEERING.
FARM JOURNAL, VOL 93, NO 8, AUGUST 1969, P 26C-26D. 1 FIG.
*FLOATING AERATOR, SUSPENDED SOLIDS, VOLATILE SOLIDS.
05D;05E.
RESEARCH AT PURDUE UNIVERSITY INDICATES THAT A FLOATING AERATOR IN A LAGOON CAN PROVIDE A LOW COST SYSTEM THAT PROMISES TO AVOID POLLUTION DANGERS AND SAVES LABOR. MANURE IS DUMPED INTO THE LAGOON ONCE EACH DAY ALTHOUGH IT IS BETTER TO HAVE IT CONTINUOUSLY TRICKLE IN. EXTRA WATER IS ADDED TO BRING THE SOLIDS CONTENT DOWN TO 2% OR 3% FOR TOP EFFICIENCY. THE AERATOR, A BIG DOUGHNUT-LIKE FLOAT WITH AN ELECTRIC MOTOR ON TOP DRIVING AN IMPELLER, RUNS CONTINUOUSLY. THE IMPELLER FORCES A SPRAY OF SLURRY UP OVER THE FLOAT, MIXING AIR INTO THE LAGOON, SO AEROBIC BACTERIA CAN BREAK DOWN MANURE WITHOUT ODORS. PERIODICALLY A SMALL PUMP PULLS OUT SOME OF THE MIXED SLURRY AND SPRINKLES IT THROUGH A 'BIG GUN' TYPE NOZZLE ONTO GRASSLAND. THE IRRIGATION LOWERS THE LAGOON, WHICH ALLOWS MORE WATER DILUTION AND REMOVES THE SUSPENDED SOLIDS THAT WON'T DECOMPOSE. OTHER ADVANTAGES INCLUDE LOW LABOR COST AS COMPARED TO PITS AND SPREADERS, AND MINIMAL MANAGEMENT. ITS BIGGEST DISADVANTAGE MIGHT BE GETTING THE MANURE INTO THE LAGOON EACH DAY. (WHITE-IOWA STATE)

CONTROL OF ALGAE IN LAKES, LAGOONS AND SMALL RESERVOIRS WITH BIOGROWTH PARTITIONS.
WIXSON, B. G.; MODESITT, D. E.
MISSOURI UNIV.-ROLLA. DEPT. OF CIVIL ENGINEERING.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-270 775, IN PAPER COPY, IN MICROFICHE. COMPLETION REPORT, JUNE 1977. 41 P, 15 FIG, 5 TAB, 28 REF. OWRT A-077-MO(2), 14-34-0001-5025 AND 6026.
*BIOGROWTH PARTITIONS(LAGOONS).
05G;04A;05D
RESEARCH WAS CARRIED OUT ON THE CONTROL OF ALGAE FROM SMALL LAGOONS THROUGH LABORATORY AND FIELD STUDIES OF MANMADE BIOGROWTH SURFACES FOR REMOVING OR CONTROLLING ALGAE. THREE LAB-SCALE STABILIZATION LAGOONS WERE MODIFIED WITH THE ADDITION OF BIOGROWTH SHEETS AND OPERATED WITH 30-DAY AND 15-DAY DETENTION PERIOD. PRINCIPAL PARAMETERS MEASURED WERE COD, SUSPENDED SOLIDS (SS), DISSOLVED OXYGEN (DO), PH, CARBON DIOXIDE, (CO2), AND MICROBIAL POPULATIONS. EXPERIMENTAL LABORATORY RESULTS INDICATED THAT THE APPLICATION OF BIOGROWTH SHEETS WAS EFFECTIVE FOR LAGOON STABILIZATION. THE PRACTICABILITY AND DESIGN CHARACTERISTICS OF THE LAGOON MODIFICATION WERE THEN EVALUATED IN FIELD INVESTIGATIONS. ALGAL GROWTHS ON THE BIOGROWTH PANELS WERE HELPFUL IN THE CONTRO. OF ALGAE. PROBLEMS WERE ENCOUNTERED WITH SOLIDS NOT REACHING AN EQUILIBRIUM WHICH WAS ATTRIBUTED TO THE USE OF A BATCH METHOD. TANKS USING THE BIOGROWTH PARTITIONS PRODUCED A LOW BIOCHEMICAL OXYGEN DEMAND (BOD) BUT EXPERIENCED PROBLEMS WITH THE USE OF RAW SEWAGE AS A FEED. THE EFFICIENCY OF TREATMENT BY BIOGROWTH PANELS, HOWEVER, WAS NOT DEEMED TO BE OF A SIGNIFICANT INCREASE OVER THE TRADITIONAL LAGOONING METHOD.

A STUDY ON THE APPLICATION OF BIOGROWTH SHEETS TO IMPROVE LAGOON EFFLUENT QUALITY.
WIXSON, B. G.
MISSOURI UNIV., ROLLA. DEPT. OF CIVIL ENGINEERING.
AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-262 427, IN PAPER COPY, IN MICROFICHE. M. S. THESIS, 1975. 62 P, 15 FIG, 13 TAB, 31 REF, 2 APPEND. OWRT A-077-MO(1), 14-31-0001-5025&6026.
*BIOGROWTH PARTITIONS, *ALGAL GROWTH.
05D
WASTEWATER STABILIZATION LAGOONS HAVE BEEN EMPLOYED IN SMALL COMMUNITIES WHERE AVAILABLE LAND AND FAVORABLE CLIMATIC CONDITIONS ALLOW FOR UTILIZATION AS AN ECONOMICAL SECONDARY TREATMENT PROCESS. BECAUSE OF PROBLEMS ASSOCIATED WITH THE DISCHARGE OF ALGAE IN THE EFFLUENT, THE TRADITIONAL LAGOON MAY REQUIRE EITHER SOME PROCESS MODIFICATIONS OR ADDITIONAL EFFLUENT POLISHING PROCESSES IN ORDER TO MEET LOCAL WATER QUALITY STANDARDS. THE PURPOSE OF THIS STUDY WAS TO INVESTIGATE THE POSSIBILITY OF INCREASING ATTACHED ALGAL GROWTHS ON THE SURFACES OF EXPERIMENTAL BIOGROWTH SHEETS TO DECREASE ALGAL DISCHARGES AND IMPROVE THE REMOVAL EFFICIENCY OF ORGANIC MATERIALS AS MEASURED BY CHEMICAL OXYGEN DEMAND (COD). THE APPLICATION OF BIOGROWTH SHEETS WAS EFFECTIVE FOR THE ENHANCEMENT OF LAGOON STABILIZATION CAPABILITIES WITH THE ABILITY TO RETAIN LARGE MICROBIAL SOLIDS, OR THOSE WITH A SIZE LARGER THAN THE SCREEN OPENINGS, FROM BEING DISCHARGED. HOWEVER, THE PRACTICABILITY AND DESIGN CHARACTERISTICS OF THE LAGOON MODIFICATION WITH THE APPLICATION OF BIOGROWTH SHEETS SHOULD BE EVALUATED FURTHER WITH ADDITIONAL FIELD INVESTIGATIONS.

UPGRADING FACULATIVE WASTEWATER LAGOONS WITH VASCULAR AQUATIC PLANTS
WOLVERTON, B. C.; MCDONALD, R. C.
NATIONAL SPACE TECHNOLOGY LABS., NSTL STATION, MS.
JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL. 51, P. 305-313, 1979. 2 FIG, 5 TAB, 24 REF.
FIELD 05D, 05E
THE PERFORMANCE OF A SINGLE-CELL, FACULTATIVE WASTEWATER LAGOON HAS BEEN SIGNIFICANTLY IMPROVED WITH THE INTRODUCTION OF VASCULAR AQUATIC PLANTS. WATER HYACINTH (EICHBORNIA CRASSIPES) WAS THE DOMINANT PLANT FROM APRIL TO NOVEMBER; DUCKWEEK (LEMNA AND SPIRODELA SPP.) FLOURISHED FROM DECEMBER TO MARCH. THIS 2-HA LAGOON RECEIVED APPROXIMATELY 475 M3/D OF UNTREATED WASTEWATER AND HAD A 5-DAY BIOCHEMICAL OXYGEN DEMAND LOADING RATE OF 22 TO 30 KG/HA.D. DURING THE FIRST 14 MONTHS OF OPERATION WITH AQUATIC PLANTS, THE AVERAGE INFLUENT 5-DAY BIOCHEMICAL OXYGEN DEMAND WAS REDUCED BY 95% FROM 110 MG/L TO AN AVERAGE OF 5 MG/L IN THE EFFLUENT. THE AVERAGE INFLUENT SUSPENDED SOLIDS WERE REDUCED BY 90% FROM 97 MG/L TO 10 MG/L IN THE EFFLUENT. (DEAL-EIS)

WATER HYACINTHS AND ALLIGATOR WEEDS FOR FINAL FILTRATION OF SEWAGE
WOLVERTON, B. C.; MCDONALD, R. C.; GORDON, J.
NATIONAL SPACE TECHNOLOGY LABS., BAY SAINT LOUIS, MS.

AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS N76-27721, IN PAPER COPY, IN MICROFICHE. NASA TECHNICAL MEMORANDUM TM-X-72724, INTERIM PROGRAM TEST RESULTS, MAY 1975. 8 P. 2 TAB, 19 REF. RTOP 644-02-02.
FIELD 05D, 05G
WATER HYACINTH (EICHHORNIA CRASSIPES) AND ALLIGATORWEED (ALTHERNANTHERA PHILOXEROIDES) REMOVED 60-90% OF VARIOUS POLLUTANTS FROM DOMESTIC SEWAGE IN TESTS OF THEIR USEFULNESS AS SECONDARY AND TERTIARY FILTRATION SYSTEMS. PLANTS WERE TESTED WITH INFLUENT AND EFFLUENT SEWAGE WATER SAMPLES FROM THE WASTEWATER LAGOON AT BAY ST. LOUIS, MISSISSIPPI. WATER HYACINTH ACHIEVED AVERAGE REDUCTIONS IN INFLUENT SAMPLES OF 92% KJELDAHL NITROGEN (CONTROL 18%), 60% TOTAL PHOSPHORUS (CONTROL 12%), AND 97% BOD5 (CONTROL 61%). IN EFFLUENT SAMPLES THE REDUCTIONS WERE 75% SUSPENDED SOLIDS (CONTROL 15%), 75% TOTAL KJELDAHL NITROGEN (CONTROL 15%), 87% TOTAL PHOSPHORUS (CONTROL 11%), 77% BOD5 (CONTROL 6%), AND 82% TOTAL ORGANIC CARBON (CONTROL INCREASED 28%). IN ALL EFFLUENT SAMPLES EXPOSED TO WATER HYACINTH OR ALLIGATORWEED THERE WAS NO EVIDENCE OF ALGAE AFTER TWO WEEKS. ALLIGATORWEED-TREATED INFLUENT INCREASED IN PH FROM 7.1 TO 7.4 OVER TWO WEEKS, AND EFFLUENT DECREASED FROM 8.9 TO 7.2. AFTER TWO WEEKS ALLIGATORWEED ACHIEVED REDUCTIONS IN INFLUENT OF 98% TOTAL KJELDAHL NITROGEN AND 71% TOTAL PHOSPHORUS. FOR EFFLUENT THE REDUCTIONS WERE 97% TOTAL SUSPENDED SOLIDS, 83% TOTAL KJELDAHL NITROGEN, 59% TOTAL PHOSPHORUS, AND 90% BOD5. BOTH PLANTS ALSO REMOVED TOXIC TRACE METALS, BUT WERE FREE OF TOXIC LEVELS OF THE METALS AFTER A TWO-WEEK GROWTH PERIOD, RENDERING THEM SUITABLE FOR FEED OR FOOD PRODUCTS.

WATERHYACINTHS - A NUISANCE OR A BENEFIT
WOLVERTON, B. C.
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, BAY SAINT LOUIS, MS. NATIONAL SPACE TECHNOLOGY LABS.
IN: PROCEEDINGS, RESEARCH PLANNING CONFERENCE ON AQUATIC PLANT CONTROL PROGRAM, 22-24 OCTOBER 1975, CHARLESTON, S.C., P 110-111, DECEMBER 1976. 8 REF.
FIELD 05G, 05D, 04A
WATER HYACINTH, EICHHORNIA CRASSIPES, CAN BE USED BENEFICIALLY FOR REMOVAL OF POLLUTANTS FROM WASTE WATER AND FOR PRODUCTION OF MANY USEFUL RAW MATERIALS. IN SEWAGE LAGOONS CONTAINING WARM, ENRICHED SEWAGE, WATER HYACINTHS GROW AT A PHENOMENAL RATE OF 8-16 TONS OF BIOMASS PER ACRE PER DAY AND ARE CAPABLE OF ABSORBING, METABOLIZING, AND CONCENTRATING LARGE AMOUNTS OF CHEMICAL POLLUTANTS AT PREDICTABLE RATES, RENDERING THE PLANTS SUITABLE FOR BIOLOGICAL HEAVY METAL MONITORING SYSTEMS. IN WASTE TREATMENT LAGOONS THEY CAN REDUCE TOTAL SUSPENDED SOLIDS AND BOD5 LEVELS AND REMOVE NUTRIENTS AND OTHER POLLUTANTS. ANIMAL FEED AND FERTILIZER CAN BE PRODUCED FROM WATER HYACINTHS GROWN IN DOMESTIC SEWAGE FREE OF TOXIC HEAVY METALS, AND METHANE GAS FROM PLANTS GROWN IN ANY TYPE OF CHEMICAL OR SEWAGE WASTEWATERS. HARVESTED PLANTS POSSESS VALUABLE PROTEIN, NUTRIENTS, AND OTHER MINERALS. ECONOMICAL TRANSPORATION AND UTILIZATION OF THE HARVESTED MATERIAL REQUIRES DRYING, BECAUSE THE PLANTS CONTAIN ABOUT 95% WATER BY WEIGHT. MECHANICAL DEWATERING IS UNSUITABLE AS PRESSING RESULTS IN LOSS OF LARGE QUANTITIES OF NUTRIENTS. A NEWLY DESIGNED SOLAR DRYING SYSTEM, WHICH WILL BEGIN OPERATION IN APRIL-MAY 1976, WILL REDUCE MOISTURE TO AN OPTIMUM 5%. WATER HYACINTHS GROWN IN NUTRIENT-RICH SEWAGE CONTAIN UP TO 20-25% CRUDE PROTEIN BY DRY WEIGHT. (LYNCH-WISCONSIN)

Appendix A

Excerpts from the Federal Register

Federal Register

FRIDAY, OCTOBER 7, 1977
PART III

ENVIRONMENTAL PROTECTION AGENCY

WASTEWATER TREATMENT PONDS

Suspended Solids Limitations

[6560-01]

Title 40—Protection of Environment

CHAPTER I—ENVIRONMENTAL PROTECTION AGENCY

SUBCHAPTER D—WATER PROGRAMS

[FRL 769-4]

PART 133—SECONDARY TREATMENT INFORMATION

Suspended Solids Limitations for Wastewater Treatment Ponds

AGENCY: Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: This rule amends the Secondary Treatment Information regulation to allow less stringent suspended solids limitations for wastewater treatment ponds. The amendment is based on the fact that properly designed and operated wastewater treatment ponds are a form of secondary treatment which may not be capable of achieving the suspended solids limitations contained in the Secondary Treatment Information regulation without supplemental treatment processes for removal of suspended solids (primarily algae).

EFFECTIVE DATE: November 7, 1977.

FOR FURTHER INFORMATION CONTACT:

Alan Hais, Municipal Construction Division (WH-547), Office of Water Program Operations, Environmental Protection Agency, Washington, D.C. 20460 (202-426-8976).

SUPPLEMENTARY INFORMATION: On September 2, 1976, notice was published in the FEDERAL REGISTER that the Environmental Protection Agency was proposing the amendment of the Secondary Treatment Information regulation (41 FR 37223). The Secondary Treatment Information regulation contains effluent limitations in terms of biochemical oxygen demand, suspended solids and pH which must be achieved by municipal wastewater treatment plants (publicly owned treatment works) in accordance with section 301(b)(1)(B) of the Federal Water Pollution Control Act Amendments of 1972 (FWPCA). The Secondary Treatment Information regulation was promulgated pursuant to section 304(d)(1) of the FWPCA on August 17, 1973 (38 FR 22298), and amended for deletion of the fecal coliform bacteria limitations and clarification of the pH requirement on July 26, 1976 (41 FR 30786).

Fifty-five (55) of the sixty (60) comments received in response to the proposed amendment supported adjusting the suspended solids limitations for wastewater treatment ponds. The final amendment is substantially the same as proposed, with the only significant change noted below. A number of the commenters, while agreeing in principle with the proposal, requested clarification on certain points. The responses to these and the other major comments are also discussed below.

DISCUSSION OF MAJOR COMMENTS

MAXIMUM FACILITY DESIGN CAPACITY

The proposed amendment (§ 133.103(c) (special considerations) indicated, in part, that the suspended solids limitations could be adjusted for wastewater treatment ponds with a maximum facility design capacity of one million gallons per day (mgd) or less. This provision was included because the Agency believes that the supplemental treatment methods, which are often needed to achieve the suspended solids limitations of § 103.102(b) with wastewater treatment ponds, unavoidably add to the complexity of designs and may strain the operational capabilities of small communities where the vast majority of wastewater treatment ponds are used. The one million gallons per day maximum facility design capacity was based on a population of 10,000 and an average wastewater flow of 100 gallons per capita per day. A number of comments were received which indicated specific instances where wastewater flows to wastewater treatment ponds in communities of 10,000 population or less exceed one mgd. In recognition of the fact that there may be valid reasons for wastewater flows to exceed 100 gallons per capita per day, the final rule has been changed to indicate that the suspended limitations may be adjusted for wastewater treatment ponds with a maximum facility design capacity of two mgd or less.

A number of comments were also received which requested a clarification of the term "maximum facilities design capacity." As the term implies, it is the flow rate which is used as the design basis for sizing wastewater treatment facilities. In most instances design capacities are expressed in terms of annual average flows, even though there may be seasonal variations in flow rates which obviously must be accounted for in the sizing of treatment facilities.

APPLICABILITY OF THE REGULATION

A number of comments questioned whether the suspended solids requirements for privately or Federally owned ponds treating sanitary wastewater could be adjusted as a result of the change to 40 CFR 133. It is clear that section 304(d)(1) of the FWPCA requires promulgation of standards directly applicable to publicly owned treatment works only and therefore 40 CFR 133 is not directly applicable to private or Federal wastewater treatment ponds. However, EPA has authority under section 402 of the Act to issue permits where no effluent limitation standards have been promulgated and to fashion conditions on a case-by-case basis premised on EPA's best technical judgment. In fashioning such conditions, EPA may consider any available information. Accordingly, the provisions of § 133.103(c) may be considered as guidance in conjunction with other information in determining individual NPDES permit requirements for privately and Federally owned sewage treatment plants which are not subject to effluent limitation guidelines proposed or promulgated under sections 301, 304, and 306 of the FWPCA.

COMMENTS WHICH DID NOT SUPPORT THE RULE CHANGE

One commenter stated that the amendment is not consistent with the FWPCA because section 304(d) contemplates secondary treatment limitations that do not vary for different treatment processes. Two of the comments which objected to the rule change indicated that the amendment is not needed because technology is available to enable small communities to comply with the existing requirements of 40 CFR 133. Two comments also stated an objection to the amendment on the grounds that some small communities already comply or are in the process of complying with the original requirements.

The legislative history of the FWPCA indicates that secondary treatment may be considered to represent a range of removals (H. Rep. 92-911, p. 101, Leg. Hist. p. 788). Based on this concept of range, there are different subcategories of treatment technologies within the broad category of secondary treatment. In this instance which is clearly supported by historical, technical and economic data, EPA is exercising its authority to define secondary treatment through categorization. Wastewater treatment ponds, without supplementary suspended solids removal processes, have traditionally been considered a form of secondary treatment for small communities. Moreover, wastewater treatment ponds have been extensively used by small communities in such applications primarily because of their low cost and operational simplicity.

As stated in the preamble to the proposed rulemaking, methods for removing excessive suspended solids (algae) from wastewater treatment pond effluents have been developed but have not been widely demonstrated in all climatic regions of the country. The Agency was faced with the fact that there was a lack of confidence both in the capabilities of conventional pond systems and in the use of supplementary devices which would effectively rule out the continued use of wastewater treatment ponds to achieve the secondary treatment requirements in many sections of the country. The Environmental Protection Agency believes that wastewater treatment ponds play a vital role in the Nation's water pollution control strategy and that, because of their advantages of simplicity, low cost and minimal energy requirements, ponds should be retained as an option for smaller communities. The Agency also recognizes that suspended solids due to live algae in pond effluents have fundamentally and substantially different characteristics than sewage solids or solids from other treatment processes. It is for these reasons the final rulemaking is being adopted substantially as proposed. Viewed in other terms, adoption of the amendment for ponds will result in

significant economic benefits, particularly for small communities. It is estimated that the projected savings in capital construction costs alone will be in excess of one billion dollars nationwide.

In promulgating this amendment to 40 CFR 133 for small wastewater treatment ponds, however, the Environmental Protection Agency does not intend to imply that supplemental treatment devices such as rock filters or intermittent sand filters are not acceptable methods for upgrading pond performance. In many instances where ponds presently do not meet discharge requirements pursuant to specific quality standards, upgrading can be economically accomplished while generally preserving the basic concept of simplified operation. The Agency strongly believes that any large scale approach to replace ponds with mechanical plants would be ill-advised because the previously mentioned advantages of ponds for small communities must be sacrificed.

RELATIONSHIP TO INDUSTRIAL EFFLUENT LIMITATIONS

Comments were received which supported the position that less stringent suspended solids limitations should also be applied to industrial wastewater treatment ponds. Section 304(d)(1) of the FWPCA requires that EPA "publish information * * * on the degree of effluent reduction attainable through application of secondary treatment." The factors to be considered in setting effluent limitations for industrial discharges pursuant to section 304(b) of the FWPCA are distinct from the section 304(d)(1) criteria. In consideration of these statutory differences, EPA clearly has authority to establish different effluent limitations for municipal and industrial discharges with regard to the control of one or more pollutant parameters.

ADJUSTMENT OF THE BIOCHEMICAL OXYGEN DEMAND (BOD) LIMITATIONS FOR PONDS

A number of comments suggested that an adjustment of the BOD limitations of 40 CFR 133 should also be allowed for wastewater treatment ponds. An equal number of commenters supported the position that the suspended solids limitation of 40 CFR 133 is the only parameter that properly designed and operated ponds cannot meet.

While there is not an extensive amount of routine monitoring data available to precisely define wastewater treatment pond performance, the majority of the State Agencies with responsibilities in this area expressed the belief during the development of the amendment that wastewater treatment ponds are generally capable of meeting the BOD requirements of 40 CFR 133.102. The Agency believes that adoption of the amendment, as proposed, will effectively ensure the continued acceptability of wastewater treatment as a secondary treatment process. It is important to recognize, however, that many of these facilities will still have to be upgraded to meet the BOD limitations of 40 CFR 133, which remain unchanged.

THE USE OF SUSPENDED SOLIDS AS A REGULATORY PARAMETER FOR WASTEWATER TREATMENT PONDS

Comments received from four State Agencies indicated that suspended solids limitations should be eliminated entirely as a regulatory parameter for wastewater treatment ponds. The Environmental Protection Agency recognizes that, because suspended solids limitations set in accordance with § 133.103 (c) are to be based on a sampling of ponds which meet the BOD requirements of 40 CFR 133, BOD removal capability will be the major factor used in determining the adequacy of wastewater treatment pond designs. However, the statutory history of the FWPCA has been interpreted to require that standards for publicly owned treatment works include limitations on both BOD and suspended solids. Furthermore, EPA considers suspended solids to be a pollutant parameter for which regulatory control is important.

AVAILABILITY OF SUSPENDED SOLIDS MONITORING DATA

Several comments were received which supported the view that there is insufficient suspended solids monitoring data available to reliably establish alternative limitations for ponds in accordance with § 133.103(c). A number of other commenters provided actual monitoring data or indicated that such data is currently available. During the period of time since the amendment was proposed, the EPA Regional Offices have been requested to begin compiling data which could be used to establish suspended solids limitations for ponds in accordance with § 133.103(c). Efforts to date have indicated that sufficient data is available. Furthermore, preliminary determinations have demonstrated a reasonable degree of consistency nationwide.

REQUESTS FOR CLARIFICATION

Comments were received which requested clarification of the following aspects of the rule change:

(1) What types of wastewater treatment ponds are covered by § 133.102(c)? As indicated in § 133.102(c), adjustment of the suspended solids limitations may be made in cases where waste stabilization ponds are the sole process used for secondary treatment. Determination of the types of facilities to which § 133.103 (c) can be applied will be in accordance with the terminology section of the EPA technical bulletin, "Wastewater Treatment Ponds" (EPA 430/9-74-011). Specifically included are photosynthetic and aerated ponds. The amendment is not applicable to polishing or holding ponds which are preceded by other biological or physical/chemical treatment processes capable of secondary treatment.

(2) Do the provisions of § 133.103(c) apply to new facilities? Yes, the suspended solids limitations for new wastewater treatment ponds can be set in accordance with the provisions of § 133.103(c). It must be recognized, however, design standards for new wastewater treatment ponds may be more stringent than those used in the determination of "best waste stabilization pond technology" in cases where the States or the EPA Regional Offices determine that such design standards are important for the overall reliability of new pond systems in that area.

(3) Does the amendment apply to the criteria for best practicable waste treatment technology? Yes, the criteria for best practicable waste treatment technology contained in Alternative Waste Management Techniques for Best Practicable Waste Treatment (EPA 430/9-75-013, October 1975), states that "publicly owned treatment works employing treatment and discharge into navigable waters shall, as a minimum, achieve the degree of treatment attainable by the application of secondary treatment as defined in 40 CFR 133." Unless specific revisions to the best practicable waste treatment criteria are published, or other applicable regulations are promulgated, the standards contained in 40 CFR 133, including the provisions of this amendment, will continue as the minimum requirements for treatment and discharge alternatives.

(4) Will specific guidance on implementation of the rule change be issued? As indicated previously, the EPA Regional Offices have been working on preliminary determinations for establishment of suspended solids limitations for wastewater treatment ponds in accordance with the proposed provisions of § 133.103(c). In most cases these efforts have been coordinated with the appropriate State Agencies. Draft guidance on procedures for actual implementation of the rule change has been circulated to the Regional Offices and will be finalized upon adoption of the amendment.

In consideration of the foregoing, Part 133 of Chapter I of Title 40 of the Code of Federal Regulations is amended as set forth below (section 304(d)(1) and 301 (b)(1)(B) of the Federal Water Pollution Control Act Amendments of 1972 (33 U.S.C. 1342, 1345 and 1361)).

Dated: September 28, 1977.

DOUGLAS M. COSTLE,
Administrator.

1. Section 133.103 is amended by adding paragraph (c) as follows:

§ 133.103 Special considerations.

(c) The Regional Administrator (or, if appropriate, the State subject to EPA approval) is authorized to adjust the minimum levels of effluent quality set forth in paragraphs (b)(1), (b)(2), and (b)(3) of § 133.102 for treatment works subject to this part, to conform to the suspended solids concentrations achievable with best waste stabilization pond technology, provided that: (1) waste stabilization ponds are the sole process used

for secondary treatment; (2) the maximum facility design capacity is two million gallons per day or less; and (3) operation and maintenance data indicate that the requirements of paragraphs (b)(1), (b)(2), and (b)(3) of § 133.102 cannot be achieved. The term "best waste stabilization pond technology" means a suspended solids value, determined by the Regional Administrator (or, if appropriate, the State Director subject to EPA approval), which is equal to the effluent concentration achieved 90 percent of the time within a State or appropriate contiguous geographical area by waste stabilization ponds that are achieving the levels of effluent quality established for biochemical oxygen demand in § 133.102(a).

[FR Doc.77-29316 Filed 10-5-77;8:45 am]

WEDNESDAY, NOVEMBER 15, 1978
PART IV

federal register

ENVIRONMENTAL PROTECTION AGENCY

WASTEWATER TREATMENT PONDS

Suspended Solids Limitations

[6560-01-M]

ENVIRONMENTAL PROTECTION AGENCY

[FRL-1006-1]

SECONDARY TREATMENT INFORMATION REGULATION

Suspended Solids Limitations for Wastewater Treatment Ponds

On October 7, 1977, the Environmental Protection Agency (EPA) published in the FEDERAL REGISTER (42 FR 54566) a final amendment to the secondary treatment information regulation applicable to the suspended solids limitations for certain municipal wastewater treatment ponds. The secondary treatment information regulation, 40 CFR 133, contains effluent limitations in terms of biochemical oxygen demand, suspended solids and pH which must be achieved by municipal wastewater treatment plants.

The amendment added a new paragraph (c) to § 133.103 of 40 CFR 133. This allows a case-by-case adjustment in suspended solids limitations for publicly owned waste stabilization ponds, if: The pond has a design capacity of 2 million gallons per day or less; ponds are the sole process for secondary treatment; and, the pond meets the biochemical oxygen demand limitations as prescribed by 40 CFR 133.102(a). Ponds that are not eligible for this adjustment include: Basins or ponds used as a final polishing step for other secondary treatment systems, and ponds which include complete-mix aeration and sludge recycle or return since these systems are in essence a variation of the activated sludge process. Aerated ponds without sludge recycle, however, are eligible for adjustments provided the other specific requirements are met.

The amended suspended solids limitations were determined by statistical analysis of available data. The acceptable limit was defined as that concentration achieved 90 percent of the time by waste stabilization ponds that are achieving the biochemical oxygen demand limitations of 40 CFR 133.102(a). Each State was considered separately as well as appropriate contiguous geographic areas within a State or group of States. The analysis was done by the States or the applicable EPA regional office in cooperation with the States.

A considerable amount of latitude was allowed in developing these values to account for varying conditions affecting pond use and performance across the country. Categorizations within States based on factors such as geographic location, seasonal variation and the type of pond were permitted. In some instances, the values presented below reflect these factors.

In accordance with the amended regulation, a single value corresponding to the concentration achievable 90 percent of the time may be used to establish the suspended solids limitations for ponds within a State. The concentration achievable 90 percent of the time has been generally accepted as corresponding to a 30 consecutive day average (or an average value over the period of discharge when entire duration of the discharge is less than 30 days). This interpretation is consistent with the analysis which was used as the basis for the other suspended solids and biochemical oxygen demand limitations contained in 40 CFR 133.

For this reason, a single suspended solid concentration has been listed below for ponds (or subcategory of ponds) within a State. In some cases, however, the States and EPA regional offices have agreed upon additional values, such as weekly averages or daily maximums, which will be used for compliance monitoring purposes within those States.

In some cases the data base for the analysis was quite limited and in all cases additional data are being collected. A periodic reevaluation of this expanding data base will be conducted and could result in further changes in the suspended solids limitations listed below. Several EPA regional offices have already indicated their intent to conduct a reevaluation within 2 years or less. Even though publication of these values is not a formal rulemaking procedure, public comments are welcome and will be considered in any revisions. Comments should be submitted to Director, Municipal Construction Division (WH-547), Environmental Protection Agency, Washington, D.C. 20460.

FOR FURTHER INFORMATION CONTACT:

Sherwood Reed or Alan Hais, Municipal Construction Division (WH-547), Office of Water Program Operations, Environmental Protection Agency, Washington, D.C. 20460, 202-426-8976.

Dated October 27, 1978.

THOMAS C. JORLING,
Assistant Administrator for Water and Waste Management.

[1505-01-C]

ENVIRONMENTAL PROTECTION AGENCY

Suspended Solids Limitations for Wastewater Treatment Ponds**

Location	Suspended Solids Limit* (mg/l)
Alabama	90
Alaska	70
Arizona	90
Arkansas	90
California	95
Colorado	
Aerated Ponds	75
All others	105
Connecticut	N.C.
Delaware	N.C.
District of Columbia	N.C.
Florida	N.C.
Georgia	90
Guam	N.C.
Hawaii	N.C.
Idaho	N.C.
Illinois	37
Indiana	70
Iowa	
Controlled Discharge, 3 cell	case-by-case but not greater than 80
All others	80
Kansas	80
Kentucky	N.C.
Louisiana	90
Maine	45
Maryland	90
Massachusetts	N.C.
Michigan	
Controlled Seasonal Discharge	
Summer	70
Winter	40
Minnesota	N.C.
Mississippi	90
Missouri	80
Montana	100
Nebraska	80
North Carolina	90
North Dakota	
North & East of Missouri River	60
South & West of Missouri River	100

Suspended Solids Limitations for Wastewater Treatment Ponds** (continued)

Location	Suspended Solids Limit* (mg/l)
Nevada	90
New Hampshire	45
New Jersey	N.C.
New Mexico	90
New York	70
Ohio	65
Oklahoma	90
Oregon	
East of Cascade Mts.	85
West of Cascade Mts.	50
Pennsylvania	N.C.
Puerto Rico	N.C.
Rhode Island	45
South Carolina	90
South Dakota	110
Tennessee	100
Texas	90
Utah	N.C.
Vermont	55
Virginia	
East of Blue Ridge Mts.	60
West of Blue Ridge Mts.	78
Eastern slope counties Loudoun, Fauquier, Rappahannock Madison, Green, Albemarle, Nelson Amherst, Bedford, Franklin, Patrick	case-by-case application of 60/78 limits
Virgin Islands	N.C.
Washington	75
West Virginia	80
Wisconsin	60
Wyoming	100
Trust Territories & N. Marianas	N.C.

NOTES:

N.C. - no change from existing criteria

* thirty consecutive day average or average over the period of discharge when the duration of the discharge is less than 30 days

** The values set for Iowa and Virginia incorporate a specific case-by-case provision, however, in accordance with 40 CFR 133.103(c), adjustments of the suspended solids limitations for individual ponds in all states are to be authorized on a case-by-case basis.

Appendix B

Technical Data

Alum and Polymers Investigated

Aluminum Sulfate, Liquid

Characteristics:

Liquid aluminum sulfate (or "alum") is a clear, pale greenish to brownish liquid with a pH of approximately 3.5 at 1%. Iron-free alum is colorless.

Properties:

Formula	$Al_2(SO_4)_3$
Molecular weight	342.15
Densities of solutions	See graph 1
Solubility	See graph 2

Method of Manufacture:

Liquid aluminum sulfate is made by reacting bauxite or clay with sulfuric acid and purifying the resultant liquor. Purified alumina hydrate is used to make iron-free alum.

Grades and Forms:

Commercial; iron-free

Typical Analyses:

Grade	Commercial	Iron-free
% Total soluble Al_2O_3	8.3	8.3
% Free Al_2O_3	0.1	0.1
% Total iron (as Fe_2O_3	0.2	0.004
% Actual Fe_2O_3	0.03	—
% Insoluble in water	0.01	0.005

Shipping Containers:

Tank truck
Tank car

Shipments:

Commercial grade shipped FOB all producing points.

Iron-free grade shipped FOB El Segundo, Cal.
N. Claymont, Del.
E. Point, Ga.
Detroit, Mich.
Middletown, O.
Willow, O.
Tacoma, Wash.

Shipping Regulations:

None

Product Markets and Uses:

Market	Use	Reason for use
Paper mills	Sizing paper	Fixes rosin size on paper fibers.
	Treating waste	Pigments and fibers removed by flocculation.
Sewage plants and industries	Treating sewage and industrial waste	Solids removed by flocculation. Phosphorus removed by chemical precipitation.
Water works	Water treatment	Solids removed by flocculation.

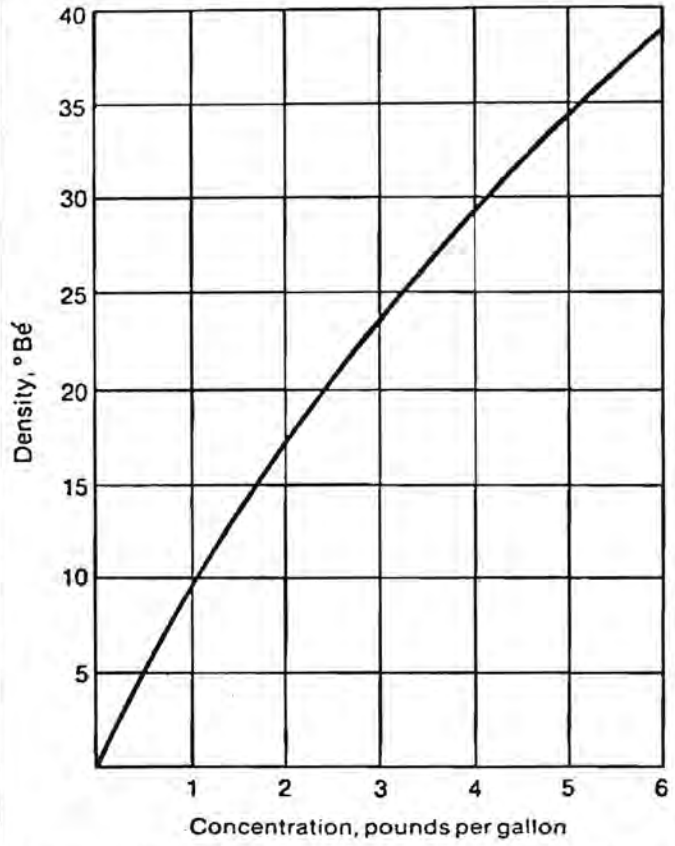

Figure 1. Densities of Commercial Dry Aluminum Sulfate Solutions at 60°F (17% Al_2O_3 in Dry Alum)

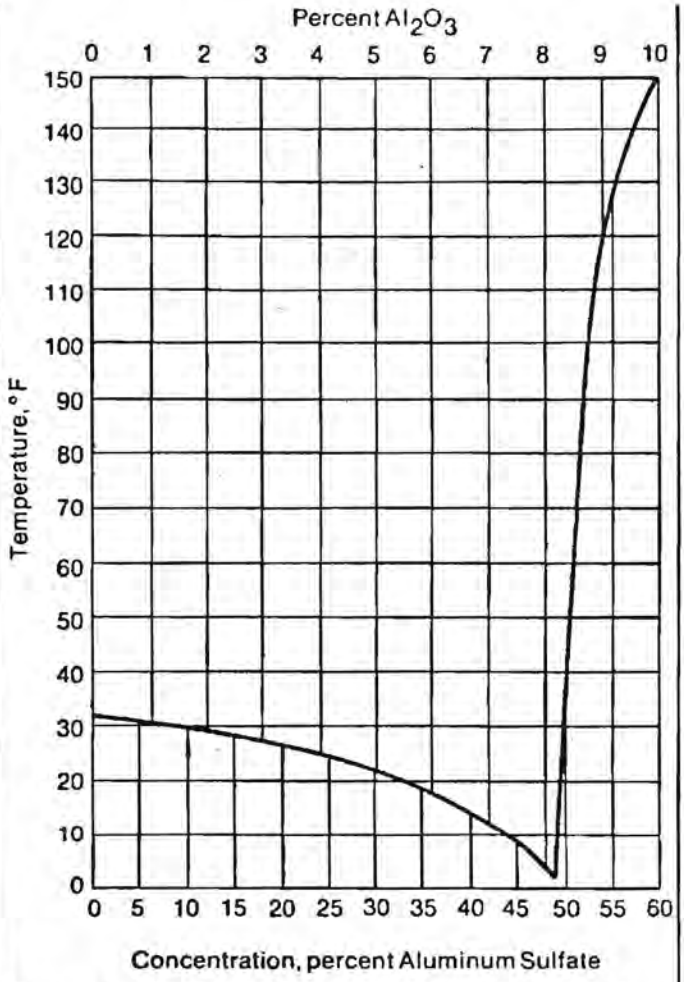

Figure 2 — Solubility of Commercial Dry Aluminum Sulfate (17% Al_2O_3 in Dry Alum)

Additional Information Available:

"Aluminum Sulfate", Bulletin No. 67-01

MAGNIFLOC® 581C flocculant

Water Clarification Treatment

MAGNIFLOC 581 C flocculant is a high molecular weight liquid cationic flocculant. It is effective as a dewatering aid in the centrifugation, filtration and flotation of industrial and municipal waste sludges. It is also useful in other dispersion separations such as in secondary clarification, settling of product streams and demulsification.

Advantages

- Easy to apply, pourable liquid which simplifies dilution, feed and handling operations.
- Economical to use — effectiveness at low dosage levels results in reduced handling and storage costs. Added savings can be realized in bulk deliveries.
- Effective over a wide pH range.
- Resistant to chlorine.
- Non-corrosive.
- Forms a low volume, compact, high-solids sludge with a higher organic content which can be readily incinerated and produces less ash.

Application

MAGNIFLOC 581 C flocculant should be metered to the system continuously by use of a corrosion-resistant, positive displacement pump and diluted 100:1 with clean water prior to being fed to the substrate. Intimate mixing with the substrate is essential for maximum effectiveness.

Principal Uses

MAGNIFLOC 581 C flocculant is a highly cationic polyelectrolyte which is especially effective in dewatering a wide range of industrial and municipal sludges.

MAGNIFLOC 581 C flocculant is recommended for use in:

- Gravity Settling Operations — Improves floc formation yielding larger floc size and faster settling rates.
- Filtration Procedures — Increases filtration rates and produces greater cake solids.
- Centrifugation — Increases throughput while improving solids capture and centrate clarity.
- Air Flotation — Results in clearer underflows, greater throughput per square foot of surface and high solids float sludge.
- Solids-Liquid-Separation systems containing residual chlorine up to several ppm.

Treatment Level

Suggested use levels are:

Sludge Dewatering	10-100 lb./ton of dry solids
Clarification	1-5 ppm
Flotation	Up to 10 ppm

Typical Properties

Appearance	Amber liquid
Specific Gravity (25°C)	1.14 – 1.18
Viscosity (25°C, cps)	4000-6000 cps
pH	4.5 – 5.5
Solubility	Infinitely soluble in water
Chemical Reactivity	Non-reactive
Shelf Life	12 to 14 Mo.
Freezing Point (°F)	0

Environmental Properties

BOD (mg/L)	100,000
COD (mg/L)	200,000
Odor Threshold No.	115
Taste Threshold No.	8,500

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Handling

Animal tests have shown that MAGNIFLOC 581 C flocculant has a low order of toxicity, and is not irritating to skin or eyes. Consequently, no more than ordinary measures of personal hygiene and plant housekeeping are needed in handling this product. Spilled polymer on floors, etc. is very slippery and difficult to "hose down" — spills should be scooped and/or wiped up prior to flushing with water. Storage in glass, stainless steel, plastic or epoxy-lined vessels is recommended. Do not use aluminum or iron in feed or storage systems.

If MAGNIFLOC 581C flocculant freezes during shipment or storage, it may be thawed and used after afitation to insure homogeniety.

Shipping

MAGNIFLOC 581 C flocculant is shipped in 55 gallon non-returnable steel drums, F.O.B. Avondale, Louisiana. For information on bulk delivery, contact your Cyanamid Representative or Sales Office.

EPA Approval

MAGNIFLOC 581 C flocculant is approved by the Environmental Protection Agency for use in the clarification of potable water at dosages of up to 20 ppm.

Technical Service

Good water management for you and for our environment depends on using the best products and the latest technology in a totally balanced program. At Cyanamid, we offer a full system of water treatment products designed to meet your needs. Your Cyanamid Sales Representative stands ready to offer information and assistance in using this product and helping you achieve our common goal — clean water.

Important Caution

The information and statements herein are believed to be reliable but are not to be construed as a warranty or representation for which we assume legal responsibility. Users should undertake sufficient verification and testing to determine the suitability for their own particular purpose of any information or products referred to herein. NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS MADE.

Nothing herein is to be taken as permission, inducement or recommendation to practice any patented invention without a license.

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5-1366 7M 6/75

NALCO 7103 is a moderate molecular weight liquid cationic polyelectrolyte developed for both industrial and municipal waste treatment systems.

NALCO 7103:

- *Reduces or eliminates the use of metal salts*
- *Produces a dense, rapid-forming, easily settled floc*
- *Increases clarifier and thickener efficiency*
- *Improves effluent quality*
- *Forms a dense, compact, and easily handled sludge*

NALCO®

7103

POLLUTION CONTROL COAGULANT

PRINCIPAL USES

NALCO 7103 is a coagulant that can be used in the following applications:

- Secondary clarification
- Dissolved air flotation
- Sludge drying beds
- Mechanical sludge dewatering

GENERAL DESCRIPTION

NALCO 7103 is a liquid product. It can be diluted with water in any proportion. Solutions can be used immediately.

Charge in Solution	Cationic
Density (Typical)	9.1 lb/gal
Odor	Slight
Viscosity (Neat)	See Figure 1
pH (Neat)	4.5
Appearance	Pale amber liquid

DOSAGE

Clarification	2—50 ppm
Thickening	10—80 lb/ton dry solids
Dewatering	20—100 lb/ton dry solids

FEEDING

Positive displacement pumps are recommended for feeding NALCO 7103. NALCO 7103 may be fed neat or as a diluted solution into a mixing tee or a water line for continuous dilution to 1% or less prior to the point of application. NALCO 7103 should be fed in a manner that will provide *maximum distribution*.

Materials of Construction

Concentrated solutions of NALCO 7103 are corrosive to lead, copper alloys, aluminum, and mild steel. Mild steel tanks, pumps, and lines are satisfactory for handling dilute (1%) solutions of NALCO 7103.

APPLICATION

The optimum dosage will generally range from 2 to 50 ppm when used as a primary coagulant. The proper dosage is readily determined by the jar test procedure using standard techniques and equipment that are part of the Nalco service program. The dosage required will vary in proportion to the solids loading so that dosage adjustment should be made as waste water characteristics change. Periodic observation of raw waste solids content and effluent turbidity will provide guidelines to optimize the dosage of NALCO 7103.

(Continued on Reverse Side)

NALCO CHEMICAL COMPANY
INDUSTRIAL DIVISION □ WATER TREATMENT CHEMICALS
2901 BUTTERFIELD ROAD □ OAK BROOK, ILLINOIS 60521

NALCO

HANDLING AND STORAGE

As with all chemicals, NALCO 7103 should be handled with reasonable care. NALCO 7103 should be handled as a mildly acidic product. Avoid contact with skin, eyes, and clothing. Use in a well ventilated area. Avoid prolonged or repeated breathing of vapors and do not take internally. In case of contact with skin, wash with water. For eyes, wash with water for 15 minutes and see a physician.

Suggested in-plant storage of NALCO 7103 is one year in unopened drums. Optimum storage temperature is 70°F. Although freezing is harmless, it should be avoided, since lower temperatures increase product viscosity. Bulk 7103 should be stored in lined tanks (Plasite 7122 or equivalent). Stainless steel (304 or 316) or rubber lined tanks may also be used. Consult your local Nalco Representative for recommended tank designs.

Solutions of NALCO 7103 greater than 10% are stable for one week.

SHIPPING

NALCO 7103 is available in bulk or in 55-gallon, non-returnable lined steel drums containing 500 pounds net.

NOTE: This bulletin shall not be construed as recommending the infringement of any patent nor extending any license, expressed or implied, nor assuming any liability under any issued or pending patent.

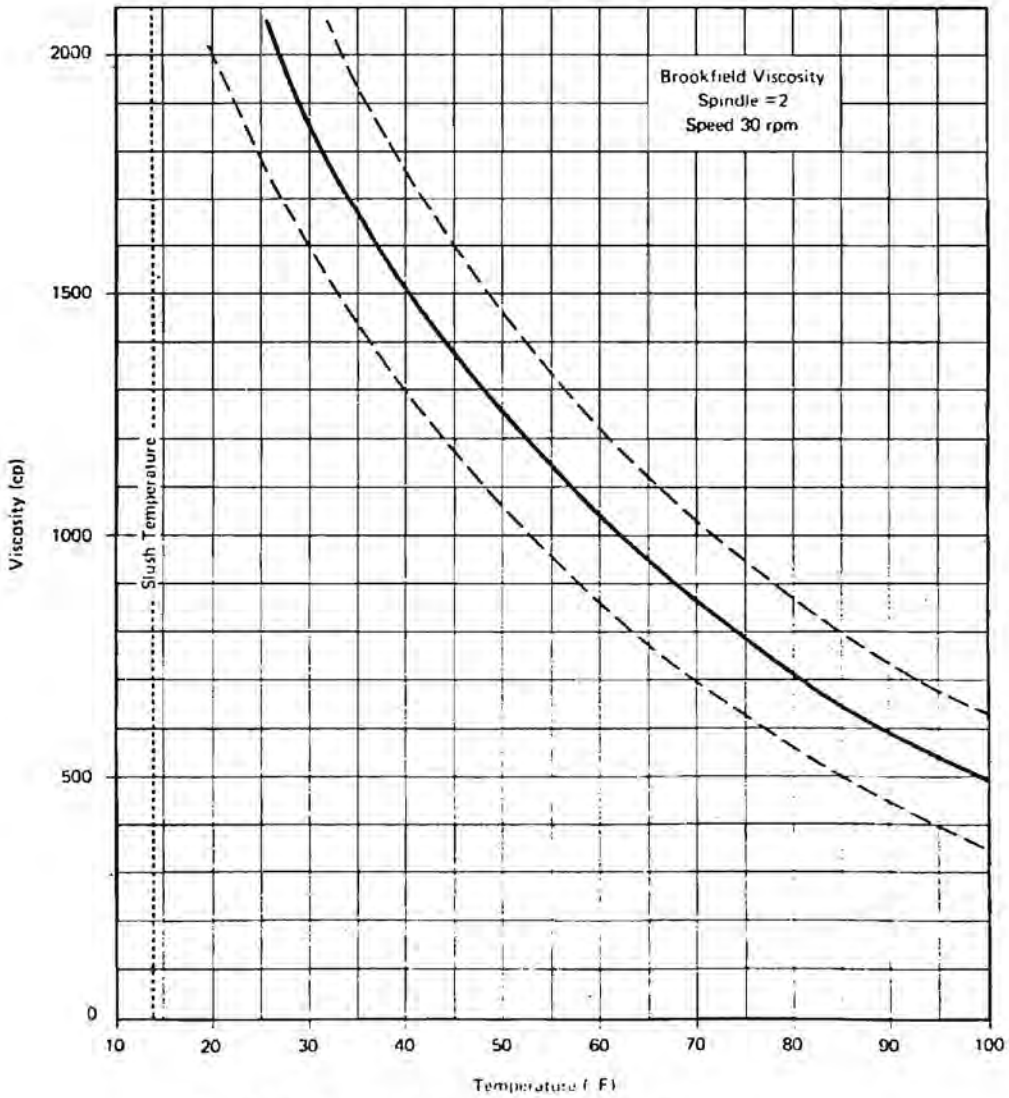

FIGURE 1 – *Typical viscosity as function of temperature*

NALCO 7132 is a moderate molecular weight liquid cationic polyelectrolyte developed for both industrial and municipal waste treatment.

NALCO® 7132

COAGULATION CHEMICAL FOR WASTE TREATMENT

PRINCIPAL USES

NALCO 7132 is effective as a primary coagulant providing the positive charge required to neutralize negative colloidal particles and then bridging these particles to form a floc. NALCO 7132, a liquid product, adds no ash to the settled and thickened solids therefore minimizing sludge volumes.

NALCO 7132 may be used to treat any industrial or municipal waste water or sludge to optimize coagulation, suspended solids removal, and/or sludge handling. Typical uses include:

- coagulant for steel mill wastes
- coagulant for paper mill wastes
- coagulant for municipal wastes
- filter aid for sand filters
- sludge conditioner for centrifuges, vacuum filters, and sludge thickeners.

NALCO 7132 can be used with an inorganic primary coagulant such as alum, aluminate, or ferric salts to reduce the amount of inorganic needed. Since less hydroxide is formed, sludge volumes are reduced.

GENERAL DESCRIPTION

NALCO 7132 is a liquid product. It is specifically formulated for rapid dissolving in a solution make-up tank and can be used immediately after the solution reaches uniform consistency.

Charge in Solution	Cationic
Specific Gravity	1.16 (Approx)
Odor	Slight
Color	Clear pale amber
Viscosity (Neat)	700 cp
Density	9.67 lb/gal
Freezing Point	10°F

APPLICATION AND DOSAGE

The optimum dosage will generally range from 2 to 50 ppm when used as a primary coagulant. The proper dosage is readily determined by the jar test procedure using standard techniques and equipment which are part of the Nalco service program. The dosage required will vary in proportion to the solids loading so that dosage adjustment should be made as waste water characteristics change. Periodic observation of raw waste solids content and effluent turbidity will provide guidelines to optimize the dosage of 7132.

DOSAGE

Thin waste streams	2 — 50 ppm
Sludge dewatering	20 — 100 lb/ton dry solids

(Continued on Reverse Side)

NALCO CHEMICAL COMPANY
INDUSTRIAL DIVISION □ WATER TREATMENT CHEMICALS
2901 BUTTERFIELD ROAD □ OAK BROOK, ILLINOIS 60521

SUBSIDIARIES IN AUSTRIA, BRAZIL, COLOMBIA, ITALY, MEXICO, SPAIN, SWEDEN, SWITZERLAND, VENEZUELA AND WEST GERMANY. AFFILIATES IN AUSTRALIA, CANADA, SOUTH AFRICA, UNITED KINGDOM AND THE UNITED STATES.

NALCO

FEEDING

Centrifugal or positive displacement pumps may be used to apply 7132. Concentrated solutions are corrosive to lead, copper alloys, aluminum, and mild steel. Mild steel tanks, pumps, and lines are satisfactory for handling dilute (1% solutions) NALCO 7132.

NALCO 7132 should be metered into a mixing tee or a water line for continuous dilution to 1% or less prior to the point of application. NALCO 7132 should be fed in a manner that will provide maximum distribution.

SHIPPING AND STORAGE

NALCO 7132 is shipped in 55-gallon, non-returnable lined steel drums containing approximately 530 lbs net weight. Storage in unopened drums for more than one year is not recommended. Optimum storage temperature is 70°F. Temperatures between 35° and 90°F are not harmful. However, freezing and overheating should be avoided. Bulk 7132 should be stored in lined tanks only. Solutions of NALCO 7132 at concentrations above 10% are stable for at least one week. Bulk quantities of 7132 are shipped FOB Clearing, Illinois.

NALCOLYTE 7105 is a low molecular weight cationic polyelectrolyte developed for both nonpotable water clarification and waste treatment systems where higher dosages may be required.

NALCOLYTE 7105 aids in:

- *Reducing or eliminating the need for metal salts*
- *Producing a dense, rapid forming, easily settled floc*
- *Increasing clarifier and thickener efficiency*
- *Improving effluent quality*
- *Forming a dense, compact, easily handled sludge*
- *Producing quality water in prechlorinated systems*

NALCOLYTE® 7105

NONPOTABLE LIQUID COAGULANT

PRINCIPAL USES

NALCOLYTE 7105 is a coagulant that can be used in the following nonpotable applications:

- Secondary clarification
- Raw water clarification
- Lime softening
- Direct filtration
- Filter aid
- Dissolved air flotation
- Mechanical sludge dewatering

GENERAL DESCRIPTION

Form	Liquid
Charge in Solution	Cationic
Color	Clear, pale amber
Odor	Slight
Density (Typical)	9.57 lb/gal
pH Neat (Typical)	7.6
Viscosity	See Figure 1
Freeze Point (Neat)	20°F
Freeze-Thaw Recovery	Complete

DOSAGE

Waste Clarification	2–40 ppm
Raw Water Clarification	1–10 ppm
Filter Aid	0.05–1 ppm
Thickening	10–60 lb/ton
Dewatering	20–80 lb/ton

FEEDING

Raw Water Clarification, Direct Filtration, and Waste Clarification

NALCOLYTE 7105 can be fed neat or as a diluted stock solution. Use a positive displacement pump to meter the product or solution into a water line for continuous dilution to 0.5% or less before the application point. NALCOLYTE 7105 should be applied at a point where efficient distribution is ensured. In raw water clarification, feed to the rapid mix zone. When preparing a stock solution in cold water, less than 60°F, additional mixing may be required.

Filter Aid Application

NALCOLYTE 7105 should be fed as a 10–30% solution to the distribution header prior to the filters. In some cases, better performance can be obtained by feeding each filter individually at the inlet flume.

Dewatering Applications

Your Nalco Representative will recommend a feed system based on your particular application.

Concentrated solutions of NALCOLYTE 7105 are corrosive to copper alloys, nickel, aluminum, and mild steel. Stainless steel (304 and 316) and PVC are suitable for transferring concentrated NALCOLYTE 7105. In all cases, install short transfer lines for neat material. Feed into a dilution water line to carry the polymer to the application point. Mild steel tanks, pumps, and lines are satisfactory for handling the dilute (less than 1% solution) product.

Care must be exercised in selecting pumps for neat (undiluted) NALCOLYTE 7105 in cold climates. As the temperature decreases, the 7105 viscosity increases. Avoid long transfer lines. If necessary, heat trace and insulate lines.

(Continued on Reverse Side)

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INDUSTRIAL DIVISION ◻ WATER TREATMENT CHEMICALS
2901 BUTTERFIELD ROAD ◻ OAK BROOK, ILLINOIS 60521

NALCO

SHIPPING

NALCOLYTE 7105 is available in bulk only. Consult your Nalco Representative for suggested storage tank design.

HANDLING

NALCOLYTE 7105 should be handled as a very mildly alkaline product. Avoid contact with skin, eyes, and clothing. In case of contact with skin, wash with water. For eyes, wash with water for 15 minutes. Call a physician. Use in a well ventilated area. Avoid prolonged or repeated breathing of vapors and do not take internally.

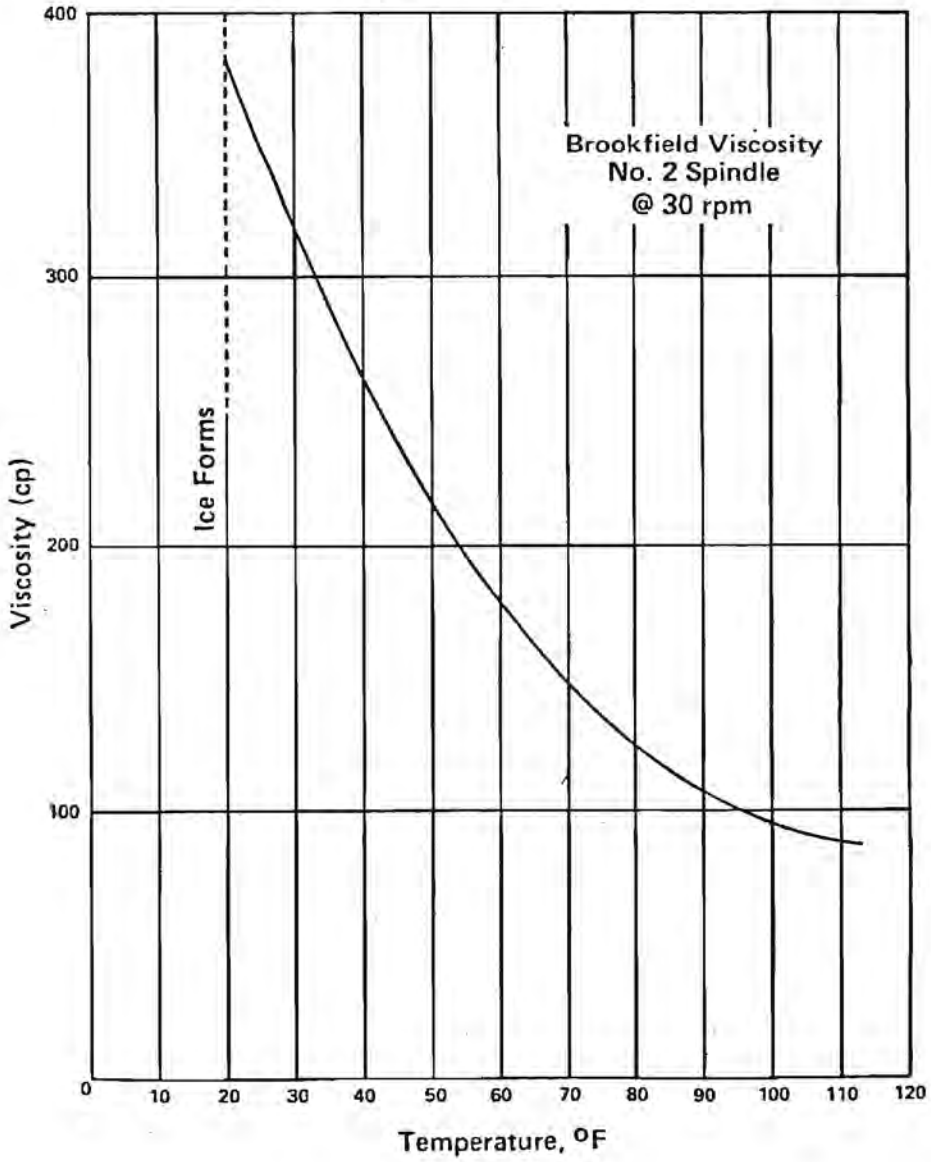
STORAGE

Bulk NALCOLYTE 7105 should be stored in lined tanks (Plasite 7122). Stainless steel (304 or 316) may also be used. Solutions of NALCOLYTE 7105 greater than 10% are stable for one week.

Although freezing is not harmful, it should be avoided since lower temperatures increase product viscosity. Should NALCOLYTE 7105 freeze, the product should be thoroughly mixed before using (after it has been completely thawed).

NOTE: This bulletin shall not be construed as recommending the infringement of any patent, or extending any license, expressed or implied or assuming any liability under any issued or pending patent.

FIGURE 1 – *Typical Brookfield Viscosity as Function of Temperature NALCOLYTE 7105*



NALCOLYTE 7107 functions as a "primary" coagulant, requiring very low dosages to react quickly with colloidal particles of turbidity and organic color in supply waters, coagulating them into rapidly settling floc. NALCOLYTE 7107 produces a clear water, eliminating the haze and standing floc often experienced with common coagulants, such as alum. NALCOLYTE 7107 forms a dense, compact, low volume, low ash content sludge, reducing disposal problems while accomplishing excellent coagulation and clarification.

NALCOLYTE® 7107

COAGULATION CHEMICAL

PRINCIPAL USES

NALCOLYTE 7107 is a high-activity cationic liquid polyelectrolyte for use in non-potable water supplies. It is extremely resistant to chlorine.

NALCOLYTE 7107 is particularly effective when:

1. Up-flow sludge blanket and sludge recirculation type clarifiers are used.
2. Precipitation softening processes are used.
3. Liquid feeding is of benefit.
4. Coagulation over a broad pH range is desired.
5. Addition of dissolved solids must be minimized.
6. Exceptional floc strength and reforming ability are desired.
7. When prechlorination is applied.

GENERAL DESCRIPTION

A liquid cationic polyelectrolyte organic coagulant.

Specific Gravity (60°F.)	1.17
Density	9.7 pounds/Gallon
pH	7.5
Color	Amber
Odor	Slight
Recommended Storage	50° - 100°F.

DOSAGE

Typically used as the "primary" coagulant at dosages ranging from 1.0 - 5.0 ppm. Alum of ferric sulfate may be used as a supplemental coagulant where high cationic demand is encountered.

FEEDING

NALCOLYTE 7107 preferably should be diluted to a 10% stock solution with clear water. The diluted solution should be fed through any type of positive displacement chemical pump and further diluted 10:1, before application.

NOTE: Concentrated solutions of NALCOLYTE 7107 are corrosive to copper or copper alloys, aluminum, mild steel and some stainless steel alloys. Mild steel tanks, pumps and lines are satisfactory for handling *dilute* NALCOLYTE 7107.

HANDLING

NALCOLYTE 7107 should be handled like a mildly alkaline product. Avoid contact with skin, eyes and clothing. Avoid prolonged or repeated breathing of vapor. Do not take internally.

NOTE: These precautions do not apply to finished water supplies treated with recommended dosages of NALCOLYTE 7107.

STORAGE

Suggested in-plant storage limit is 12 months in unopened drums. Bulk NALCOLYTE 7107 should be stored in lined tanks only. Contact your Nalco Representative for information concerning bulk storage.

SHIPPING

NALCOLYTE 7107 is shipped in 55 gallon drums containing approximately 530 pounds. NALCOLYTE 7107 is shipped F.O.B. Sugarland, Texas; Clearing, Illinois; and local warehouse points, where available.

NALCO CHEMICAL COMPANY
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180 N. MICHIGAN AVENUE ▫ CHICAGO, ILLINOIS 60601

SUBSIDIARIES IN BRAZIL, COLOMBIA, ITALY, MEXICO, SPAIN, SWITZERLAND, VENEZUELA AND WEST GERMANY. ▫ AFFILIATES IN AUSTRALIA, CANADA, SOUTH AFRICA AND UNITED KINGDOM.

NALCO

NALCOLYTE 7134 is a high molecular weight cationic polyelectrolyte developed for waste water clarification.

NALCOLYTE 7134 aids in:

- *Reducing or eliminating the need for metal salts*
- *Producing a dense, rapid forming, easily settled floc*
- *Increasing clarifier and thickener efficiency*
- *Improving effluent quality*
- *Forming a dense, compact, easily handled sludge*

NALCOLYTE® 7134

NONPOTABLE LIQUID COAGULANT

PRINCIPAL USES

NALCOLYTE 7134 is a coagulant that can be used in the following nonpotable applications:

- Secondary clarification
- Raw water clarification
- Lime softening
- Direct filtration
- Filter aid
- Dissolved air flotation
- Mechanical sludge dewatering

GENERAL DESCRIPTION

Form	Liquid
Charge in Solution	Cationic
Color	Straw yellow
Odor	Slight
Density (Typical)	9.6 lb/gal
pH Neat (Typical)	7.9
Viscosity	See Figure 1
Freeze Point (Neat)	−15°F (Approx)
Freeze-Thaw Recovery	Complete

DOSAGE

Waste Clarification	2–20 ppm
Raw Water Clarification	1–10 ppm
Filter Aid	0.05–1 ppm
Thickening	5–40 lb/ton
Dewatering	10–50 lb/ton

FEEDING

Raw Water Clarification, Direct Filtration, and Waste Clarification

NALCOLYTE 7134 can be fed neat or as a diluted stock solution. See Figure 2. Use a positive displacement pump to meter the product or solution into a water line for continuous dilution to 0.5% or less before the application point. NALCOLYTE 7134 should be applied at a point where efficient distribution is ensured. In raw water clarification, feed to the rapid mix zone. When preparing a stock solution in cold water, less than 60°F, additional mixing may be required.

Filter Aid Application

NALCOLYTE 7134 should be fed as a 10–30% solution to the distribution header prior to the filters. In some cases, better performance can be obtained by feeding each filter individually at the flume.

Dewatering Applications

Your Nalco Representative will recommend a feed system based on your particular application.

Concentrated solutions of NALCOLYTE 7134 are corrosive to copper alloys and mild steel. Stainless steel (304 and 316), PVC, or polyethylene equipment (lines and valves) are suitable for transferring concentrated NALCOLYTE 7134. In all cases, install short transfer lines for neat material. Feed into a dilution water line to carry the polymer to the application point. Mild steel tanks, pumps, and lines are satisfactory for handling the dilute (less than 1%) NALCOLYTE 7134.

Care must be exercised in selecting pumps for neat NALCOLYTE 7134 in cold climates. As the temperature decreases, the 7134 viscosity increases. Avoid long transfer lines. If necessary, heat trace and insulate lines.

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NALCO

HANDLING

NALCOLYTE 7134 should be handled as an alkaline product. Avoid contact with skin, eyes, and clothing. In case of contact with eyes, flush with water for 15 minutes. Call a physician. For skin, wash with water. Use in a well ventilated area. Avoid prolonged or repeated breathing of vapors and do not take internally.

SHIPPING

NALCOLYTE 7134 is available in bulk or 55-gallon, non-returnable lined drums. Each drum weighs approximately 520 pounds net.

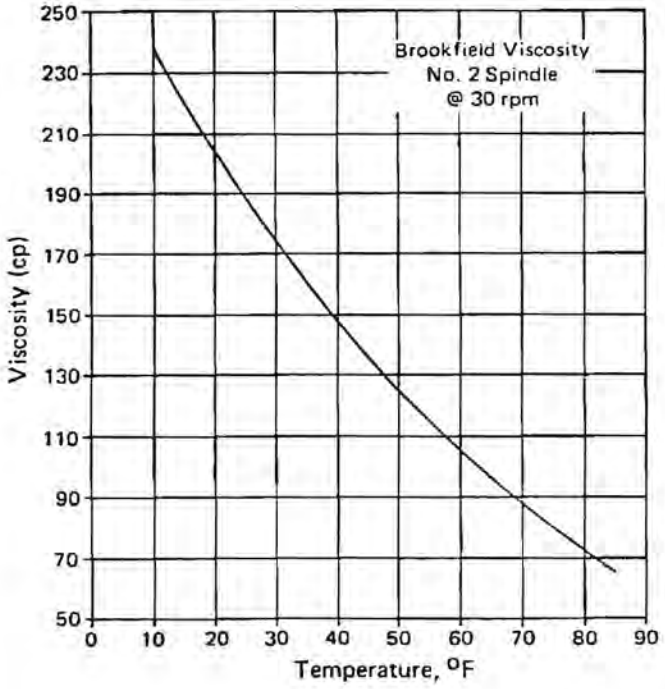
STORAGE

NALCOLYTE 7134 can be stored up to one year in unopened containers. Solutions of NALCOLYTE 7134 greater than 10% are stable for approximately one week.

Although freezing is not harmful, it should be avoided since lower temperatures increase product viscosity. Should NALCOLYTE 7134 freeze, mix the product thoroughly before using (after it has been completely thawed).

NOTE: This bulletin shall not be construed as recommending the infringement of any patent, or extending any license, expressed or implied or assuming any liability under any issued or pending patent.

FIGURE 1 – *Typical Brookfield Viscosity as a function of temperature*



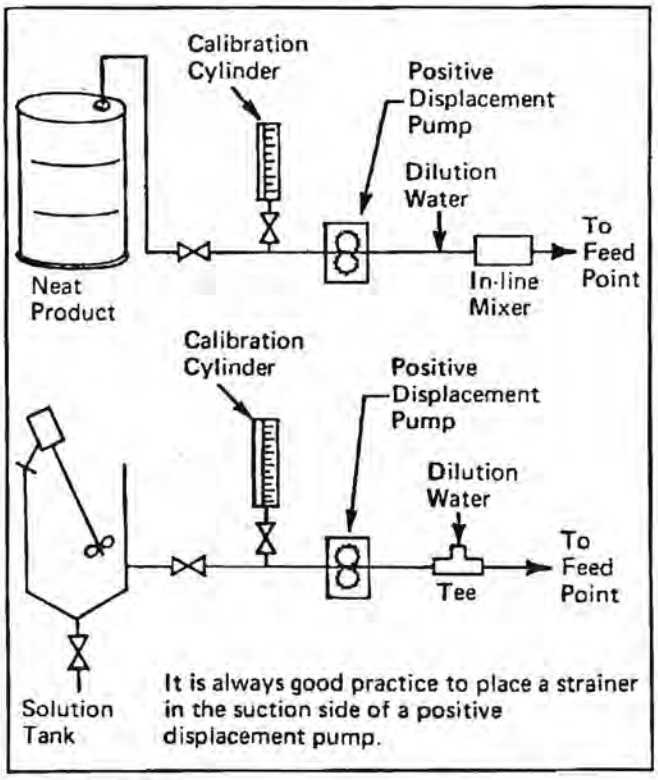


FIGURE 2 – *Recommended coagulant feed systems*

PURIFLOC* Flocculants

C31

PURIFLOC C31 Flocculant

Solid-Liquid Separation Processes

PURIFLOC C31 flocculant is a cationic polyamine which has proven very effective in increasing the efficiency of solid-liquid separation processes in both water and wastewater treatment. PURIFLOC C31 flocculant has been cleared by the U.S. Environmental Protection Agency for use in potable water up to a maximum concentration of 5.0 mg/l.

PURIFLOC C31 flocculant also has found wide application in effectively and economically conditioning sludges for dewatering.

Application	Suggested Dosage[1]
1. Vacuum Filtration	10-60
2. Air Flotation	5-40
3. Centrifugation	10-50
4. Sand-Bed Dewatering	5-40
5. Gravity Thickening	5-40

[1] lb/ton of dry solids.

Typical Properties[2]

Ionic Character	Cationic
Physical Form	Dark Amber, Viscous Liquid
Density	9.5 lbs/gal
pH (20% Solution, 20°C)	8.9
Solubility	All proportions in water
Pour Point	−26°F

[2] Laboratory values; not specification limits.

Recommended Storage Conditions

Length of Storage		Temperature	
Bulk Solution	1 yr	Bulk Solution	<122°F
Dilute Solution	2 mos	Dilute Solution	<122°F

–Continued

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Form No. 192-635-78

Handling

Dilute solutions of PURIFLOC C31 flocculant can be easily prepared using any of a variety of dispersion and dilution equipment.

The solutions of PURIFLOC C31 flocculant exhibit non-Newtonian flow characteristics. Utilizing Newtonian viscosity data and hydraulic calculations for pipe or pump sizing can result in excessively oversized systems. Additional technical data are available upon request.

Corrosivity

Solutions are essentially noncorrosive, and standard materials of construction can be used for all equipment. Zinc, aluminum, and magnesium are exceptions. Therefore, galvanized equipment should not be used. Black iron and mild steel have been used satisfactorily for handling cationic solutions. Preferred materials of construction are stainless steel and corrosion-resistant plastic.

Precautions

Toxicity and First Aid

PURIFLOC flocculants are eye irritants. Therefore appropriate eye protection such as safety glasses should be worn. If eyes become contaminated they should be flushed with plenty of low-pressure flowing water. PURIFLOC flocculants are essentially non-irritating to the skin but it is wise to avoid excessive skin exposure. Contaminated skin should be washed with soap and water and badly contaminated clothing should be removed and washed before reuse. These products have low single-dose **oral toxicity.** Acute oral LD_{50} value for PURIFLOC C31 Flocculant for the white rat is 1000 mg/kg. They should present no problem from ingestion under normal industrial use.

In case of any skin or eye irritation or other adverse human effects, get medical attention.

Combustibility

PURIFLOC flocculants (dried residues of the liquid) will burn under the right conditions of heat and oxygen supply. Fires can be extinguished by conventional means with alcohol foam, CO_2 and dry chemical methods preferred. Fire fighters may require self-contained breathing apparatus, should be careful not to get dusts or spills in eyes or on skin, and should not flush waste product into natural water resources.

Spills and Disposal

Liquid spills should be contained and absorbed with a material such as sawdust or clay. This material then can be shoveled into empty drums. Floors may be very slippery, and personnel engaged in spill clean-up should be forewarned and careful. Residues can be scraped from floors or scrubbed with commercial sodium hypochlorite bleach (normal precautions to prevent eye or skin contact or vapor inhalation are required when using bleach).

Disposal of liquid PURIFLOC flocculants, if possible, should be in water treatment plants where the "waste" liquid can assist in flocculation of total plant wastes. Disposal can be by burial in a landfill area approved for water soluble products and not immediately adjacent to potable and/or natural water resources.

In any disposal of wastes, be certain all applicable federal, state, and local regulations are met.

Environmental Considerations

The liquid cationic PURIFLOC flocculants can kill fish if released untreated into natural water. The LC_{50} of PURIFLOC C31 flocculant for the fathead minnow exposed for 96 hours in dechlorinated Lake Huron water at 50°F and pH 8.1-8.4 is 3 mg/l. Under no circumstances therefore should they be allowed into streams, lakes or other bodies of natural water, or into sewers leading to such, without first undergoing an appropriate waste treatment process by exposure to anionic materials such as bentonite or illite clays.